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LEVEL II

DEVELOPMENT OF MAINTENANCE METRICS TO FORECAST
RESOURCE DEMANDS OF WEAPON SYSTEMS
(ANALYSIS AND EVALUATION)

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A-10A	C-141A	Operations Parameters	Maintenance Requirements
B-52G	T-38A	Environmental Parameters	Avionics Equipment
FB-111A	LCOM	Maintenance Parameters	
F-15A	METRICS	Hardware Parameters	
KC-135A	Engines	Aircraft Parameters	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the method and results of the first four of eight tasks to "Develop Maintenance METRICS To Forecast Resource Demands of Weapon Systems". The purpose of these first tasks was to develop a quantitative data foundation for use in the remaining analysis tasks in developing maintenance metrics for the LCOM model. The significant results of the first four tasks were:

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a) development of an historical bibliography from over twelve hundred (1200) reviewed abstracts.

b) selection of seven (7) aircraft and four hundred sixty-three (463) equipments within thirty (30) functionally similar sub-system/equipments for detail analysis.

c) identification of one hundred ninty-three (193) different parameters to be studied as to their impact on aircraft maintenance. These parameters covered five (5) primary areas: 1) operations, 2) environmental, 3) maintenance, 4) hardware and 5) aircraft general.

d) identification and acquisition of over seven (7) million computer processable transactions and four hundred (400) supplemental data parameters. The latter data was obtained directly from the maintenance technicians at nine (9) operational units.

This document is the first of a series of five Boeing Technical Reports generating from this study, namely:

D194-10089-1	Development of Maintenance METRICS To Forecast Resource Demands of Weapon Systems (Analysis and Evaluation)
D194-10089-2	Development of Maintenance METRICS To Forecast Resource Demands of Weapon Systems (Parameter Prioritization)
D194-10089-3	Development of Maintenance METRICS To Forecast Resource Demands of Weapon Systems (Maintenance Metrics and Weightings)
D194-10089-4	Development of Maintenance METRICS To Forecast Resource Demands of Weapon Systems (Analysis and Results of Metrics and Weightings)
D194-10089-5 (AFHRL-TR-	Development of Maintenance METRICS To Forecast Resource Demands of Weapon Systems (METRICS Final Report)

SUMMARY

This report describes the results of the first four tasks of an eight task study. The total effort is intended to develop more accurate metrics and weightings to be incorporated into the Air Force method (Logistics Composite Model (LCOM)) for determining manpower and other resource requirements for operational and developing weapon systems.

PROBLEM

The increased concern with the manpower required to support weapon systems currently in operation, as well as those in development has created the need for more accurate methods of projecting maintenance requirements. Meeting this need requires the development of realistic measures of maintenance rates for all of the diverse hardware that makes up a weapon system. In addition, the impact of operations and environmental conditions needs to be identified to insure the sensitivity of the maintenance metrics that are developed.

To date, the manpower and other resource requirements essential to the Operations and Support of a weapon system have been determined using the traditional "flying hours" and "sortie rate" measures. The deficiencies of these traditional measures are well known and such measures frequently are found to be totally irrelevant; for example, many avionics items operate or are cycled greatly in excess of the related flying hours. These traditional measures are also insensitive to variations in operations and environmental conditions. The present difficulties then lie in the fact that the currently used metrics do not consider the inherent differences between the individual subsystems of a weapon system and are relatively insensitive to operational and environmental conditions.

APPROACH

The approach taken for this portion of the study effort was to identify, obtain, review and catalog related research and/or descriptive studies; select a representative cross section of aircraft and subsystems/equipments; identify

and select applicable study parameters/variables; and acquire field experience data from various maintenance management information systems and on-site visits to operational units.

The data base thus accumulated was computer processed via LCOM criteria in preparation for follow-on analysis.

RESULTS

Selected literature was screened (1200 abstracts) and applicable descriptive documents cataloged as shown in the bibliography. A matrix was developed of the seven selected aircraft versus their common subsystems/equipments. These were further screened to the 463 equipment items within the 30 subsystems that were functionally similar across the seven selected aircraft. Potential maintenance impact parameters (193) were selected from the literature and other experience data and were divided into five major categories; i.e., Operations, Environmental, Maintenance, Hardware, and Aircraft General. Computer generated data (seven million records) were carefully screened and reduced to 1.4 million records which were processed via LCOM criteria for follow-on analysis. All the above then served as the quantitative data foundation upon which the remaining tasks of the study could be conducted.

PREFACE

This report was prepared by the Boeing Aerospace Company Product Support/Experience Analysis Center, Seattle, Washington, under USAF Contract F33615-77-C-0075. This contract was initiated under Exploratory Development Area PSM 77-43 (1124). Work was accomplished under the direction of the Logistics Research Division of the Air Force Human Resources Laboratory, Air Force Systems Command with Mr. Frank Maher as the project engineer.

Data emanating from this contract, "Development of Maintenance METRICS To Forecast Resource Demands of Weapon Systems," are reported in a series of five Technical Reports. The study provided the identification of aircraft subsystems/equipments maintenance resource demand which were used to develop more accurate metrics and weightings for incorporation into the Air Force Logistics Composite Model (LCOM).

Experience Analysis Center program technical leader was George R. Herrold. Principal program analysts were Donald K. Hindes, Gary A. Walker, and David H. Wilson. Boeing's contract report number is D194-10089-1. This approved technical report (TR) includes work performed from 1 March 1978 through 15 October 1979.

The Boeing Aerospace Company wishes to express their appreciation for the technical assistance and data provided by: a) AFLC Headquarters, Aeronautical Systems Division, and Air Force Maintenance and Supply Management Engineering Team, Wright-Patterson AFB, Ohio, b) Air Weather Service (MAC) Environmental Technical Applications Center and Military Airlift Command Headquarters, Scott AFB, Illinois, c) Air Force Europe Headquarters, Ramstein AB, Germany, d) Air Training Command Headquarters, Randolph AFB, Texas, e) Strategic Air Command Headquarters, Offutt AFB, Nebraska, f) Tactical Air Command Headquarters, Langley AFB, Virginia, g) 12th FTW, Randolph AFB, Texas, h) 36th TFW, Bitburg AB, Germany, i) 58th TTW, Luke AFB, Arizona, j) 60th MAW, Travis AFB, California, k) 92nd BMW, Fairchild AFB, Washington, l) 35th TFW, Myrtle Beach AFB, South Carolina, m) 355th TFW, Davis-Monthan AFB, Arizona, and n) 380th BMW, Plattsburgh AFB, New York.

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I - INTRODUCTION

1. PURPOSE

The Air Force must be able to meet its specified mission requirements. To meet these requirements a spectrum of weapon systems must be designed, produced, maintained and operated. As the cost of sophisticated technology spirals upward, the Air Force planner must be able to maximize performance while minimizing cost. The crucial limiting parameter placed upon the weapon system spectrum is cost. Currently, it is popular to advocate different methods which provide the basis for controlling cost; such as cost of ownership and life cycle cost. All costing technologies have three aspects in common: the value of a weapon system is measured in dollars; the computation of the value is at a fixed point in time; and the function of costing the system is dependent upon the definition of variables to be included in the cost.

There are two variables and their definitions that are generally understood by all. These are the manpower and material or resources to maintain the weapon system. In a recent study conducted on the life cycle cost of the C-130E aircraft (Reference [1]) it was determined that labor accounted for 70% of the 15 year cumulative operational and support cost, resources (material) approximately 18%, with the remaining being attributed to fuel and base support. The detail distribution of these costs are shown in Figure 1.

This ever increasing bite of the total Operating and Support cost has developed considerable concern for the manpower required to support weapon systems currently in operation, as well as those in development. A study on maintenance and reliability impact on system support costs (Reference [2]) showed that some 70% of the life cycle cost funds of a new weapon system are essentially committed in the concept phase by initial planning decisions (Figure 2).

[1] "Life Cycle Cost of C-130E Weapon System" AFHRL-TR-77-46, July 1977.

[2] Maintainability/Reliability Impact on System Support Costs, AFFDL-TR-73-152, December 1973.

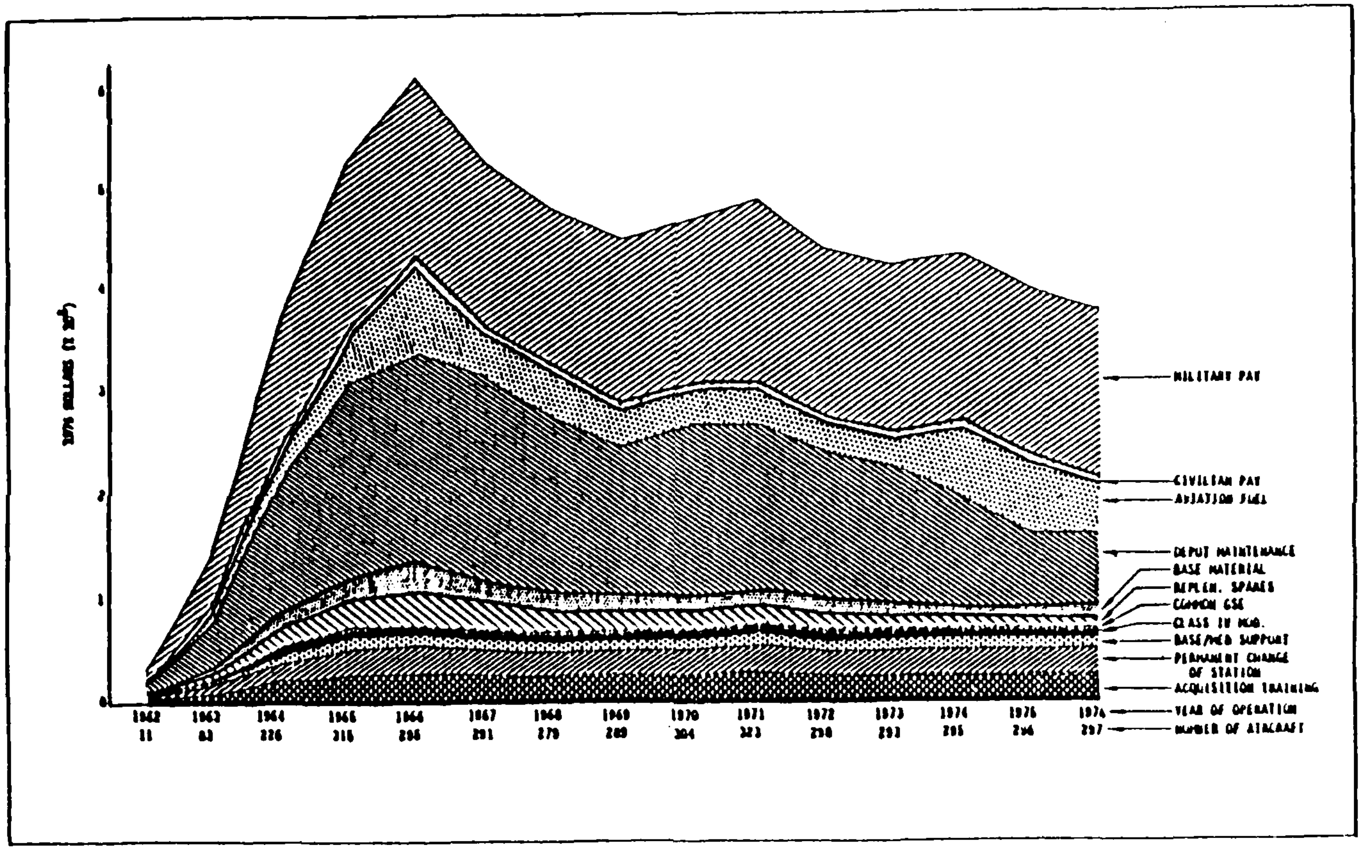


FIGURE 1 C-130E CUMULATIVE OPERATIONAL & SUPPORT COST ELEMENTS BY YEAR

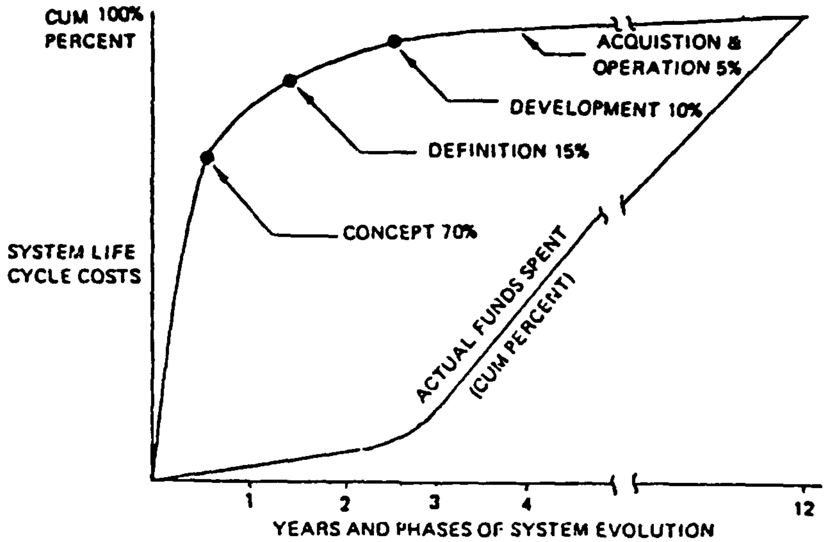


Figure 2 SYSTEMS FUNDS COMMITTED BY INITIAL PLANNING DECISIONS

This semi "locked in concrete" expenditure has created the need for more accurate methods of projecting maintenance and manpower requirements early in the design process so that trades can be made to reduce long term resource demands. Meeting this need requires the development of realistic measures of maintenance rates for all of the diverse hardware that makes up a weapon system. In addition, the impact of operations and environmental conditions need to be identified to insure the sensitivity of the maintenance metrics that are developed.

To date, the manpower and other resource requirements essential to the Operations and Support (O&S) of a weapon system have been determined using the traditional "flying hours" and "sortie rate" measures. The deficiencies of these traditional measures are well known and such measures frequently are found to be totally irrelevant (e.g., maintenance on a gun subsystem is generated by factors like the number of rounds fired, and is not affected by the number of flying hours or sorties). These traditional measures are also insensitive to variations in operations and environmental conditions (for example, many avionics equipments may operate or are cycled on the ground greatly in excess of related flying hours or number of sorties).

The present difficulties then lie in the fact that the currently used metrics do not consider the inherent differences between the individual subsystems of a weapon system and are relatively insensitive to operational and environmental conditions.

The objective of this research is to determine the maintenance, hardware, operations, environmental and aircraft general parameters which are necessary and sufficient to identify the drivers of maintenance demands for a weapon system, and to develop more accurate metrics and weightings to be incorporated into the Air Force Method (Logistics Composite Model (LCOM)) for determining manpower and other resource requirements for operational and developing weapon systems.

2. PROJECT PSM 77-43 (1124) - BACKGROUND

Beginning in 1971, an Exploratory development effort under Project PSM 77-43 (1124), "Human Resources in Aerospace System Development and Operations" concentrated on the development of a technology to predict the manpower and related resource needs required to support the operations and maintenance of a developing weapon system. Utilizing the Logistics Composite Model (LCOM), a Maintenance Manpower Model (MMM) was developed to predict the manpower requirements necessary to support a developing weapon system. This simulation technology has been documented in a series of technical reports (References [3] through [11]), and the technology has been transitioned to the Aeronautical Systems Division (ASD/ENCC) and is being utilized by other Air Force commands and agencies including Air Force Management Engineering Agency (AFMEA) and Air Force Test and Evaluation Center (AFTEC). Currently an effort under Project 1124 is directed at an expansion of the Maintenance Manpower Model (MMM) to predict the Aerospace Ground Equipment (AGE) and spares resources along with the manpower needs.

3. SCOPE

This study has been structured into two interdependent sequential phases. The first phase concentrates on aircraft avionics and engines subsystems and Phase II the remaining aircraft subsystems.

[3] through [11] See Reference List (Page 44)

4. DESCRIPTION OF TASKS

The following is a brief overview of the eight tasks developed for this study as shown in Figure 3. The first four tasks are documented in detail in this report with the remaining tasks covered in the other study reports.

PHASE I - AVIONICS AND ENGINES SUBSYSTEMS

TASK I — Identify, Obtain, and Review Related Publications
- review related studies and research dealing with maintenance rates and causes.

TASK II — Select Equipment
- develop matrices of equipment by aircraft type in order to select specific hardware for common aircraft subsystems.

TASK III — Identify Parameters
- identify maintenance, hardware, operational environmental, and aircraft general parameters which would have an impact on maintenance for the subject subsystems.

TASK IV — Identify and Integrate Data Sources
- identify, assemble, correlate, and integrate the data base on the equipment selected in Task II for the related parameters being considered in Task III.

TASK V — Analyzing and Prioritizing Parameters
- prioritize the collected data to define and test relationships between the study parameters and maintenance demand rates.

TASK VI — Maintenance Metrics Development
- develop metrics quantifying maintenance demand rates which are computable with LCOM models.

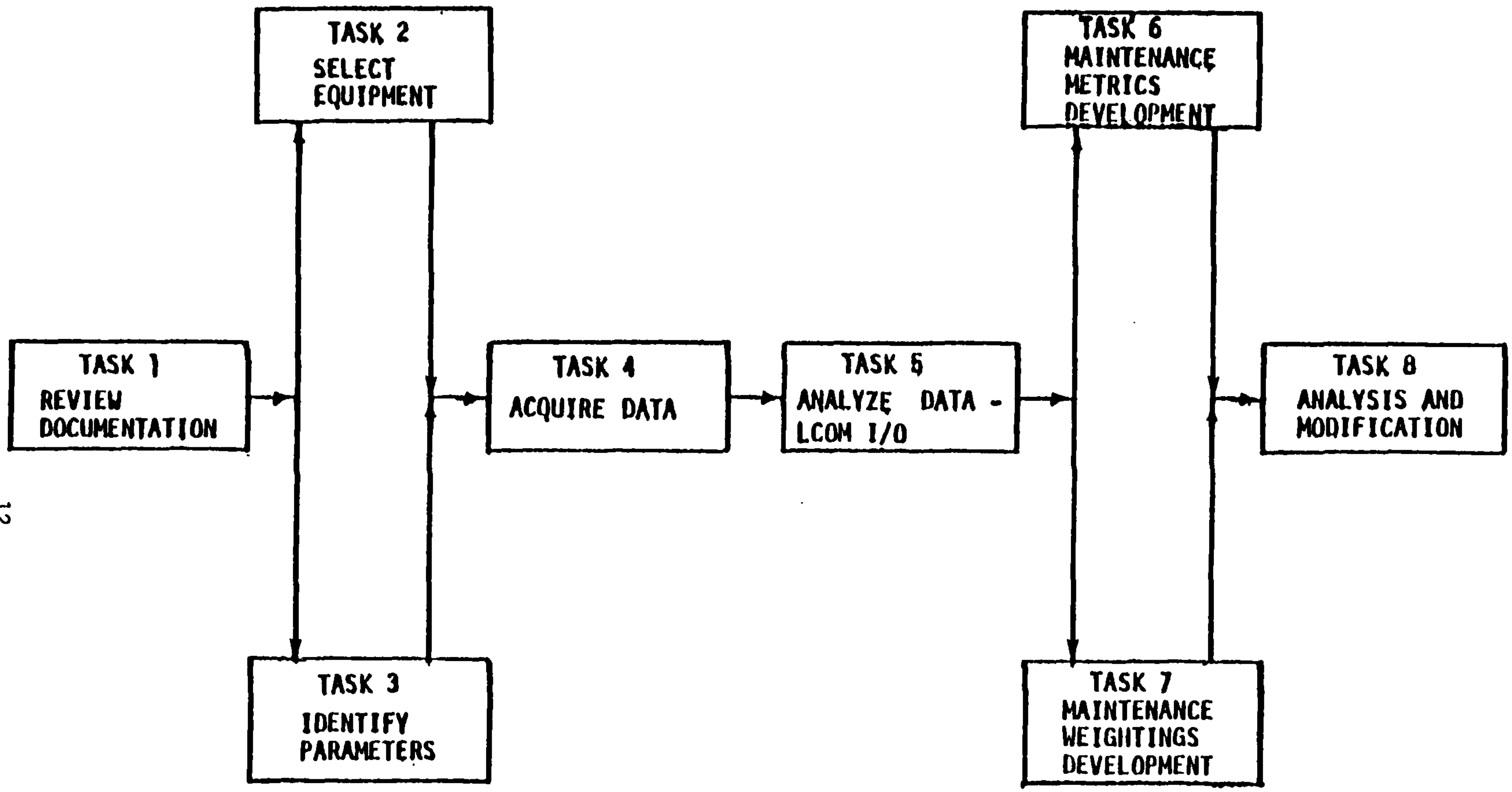


FIGURE 3 STUDY TASKS FLOW DIAGRAM

TASK VII	Maintenance Weightings Development - develop weightings, quantifying identified impacts upon maintenance demand rates.
TASK VIII	Analysis and Modification - analyze LCOM model outputs with current and the newly developed metrics and weightings.

5. SUMMARY

This report is the first of five reports completed under this total study. It describes the work accomplished during Phase I and Phase II of the study for the first four tasks as displayed in Figure 3 and enumerated in the preceding paragraphs. The other tasks are reported on in the other study reports.

The significant results obtained in these first four tasks set the stage for the remaining tasks. Task I developed a historical METRICS file of pertinent documents/reports and a bibliography from over 1200 reviewed abstracts. Task II selected seven study aircraft and produced a matrix of aircraft versus functionally common subsystems/equipments. This was further screened to 463 equipments with 30 functionally similar subsystems for detail analysis within the study. Task III established 193 parameters which could have an impact on maintenance resource demands. These distributed in the following:

a) Operations ---------- 35
b) Environmental-------- 31
c) Maintenance---------- 30
d) Hardware ------------ 81
   Avionics - 27
   Engines - 24
   Other - 30
e) Aircraft General ---- 16

TOTAL 193

Task IV saw the identification of various data sources and systems, and the acquisition of over seven million transactions. Of these, 1.4 million AFM 66-1 maintenance data records were processed per LCOM criteria. Nine operational bases were also visited to obtain over 400 supplemental data parameter inputs.

The results from these first four tasks then served as the quantitative foundation upon which the remaining analysis tasks were conducted.

II - IDENTIFY, OBTAIN, AND REVIEW RELATED PUBLICATIONS - TASK I

1. INTRODUCTION

The initial step undertaken in this study was to establish a method by which to identify, obtain, and review applicable literature. The related research and/or descriptive studies covering aircraft weapon system maintenance causes and measures/rate of occurrences was constrained to those published within the last ten years. This task was accomplished along typical steps and/or analytical sequences normally performed when conducting a data review. The five major steps, as depicted in Figure 4, were:

a) STINFO Search
b) Screen Indexes
c) Review Literature
d) Cataloged Selected Items
e) Develop Bibliography

2. STINFO SEARCH

The STINFO Search was conducted through the Boeing Aerospace Technical Library which has the capability of searching, effectively and efficiently, other technical libraries, data banks, and information repositories. The search was keyed via descriptive words that most aptly conveyed the objectives of this study. Any and all media, i.e., technical reports, manuals, etc. were considered for review.

3. SCREEN INDEXES

The products of the STINFO Search were in the form of computer listings and other types of indexes. These eminated from such repositories as DDC, DLSIE, etc. which then had to be screened, via the report title and abstract, and acquired if they appeared to have direct application to the study. Over 1200 such abstracts were reviewed which resulted in approximately 300 documents being selected as likely contributing candidates.

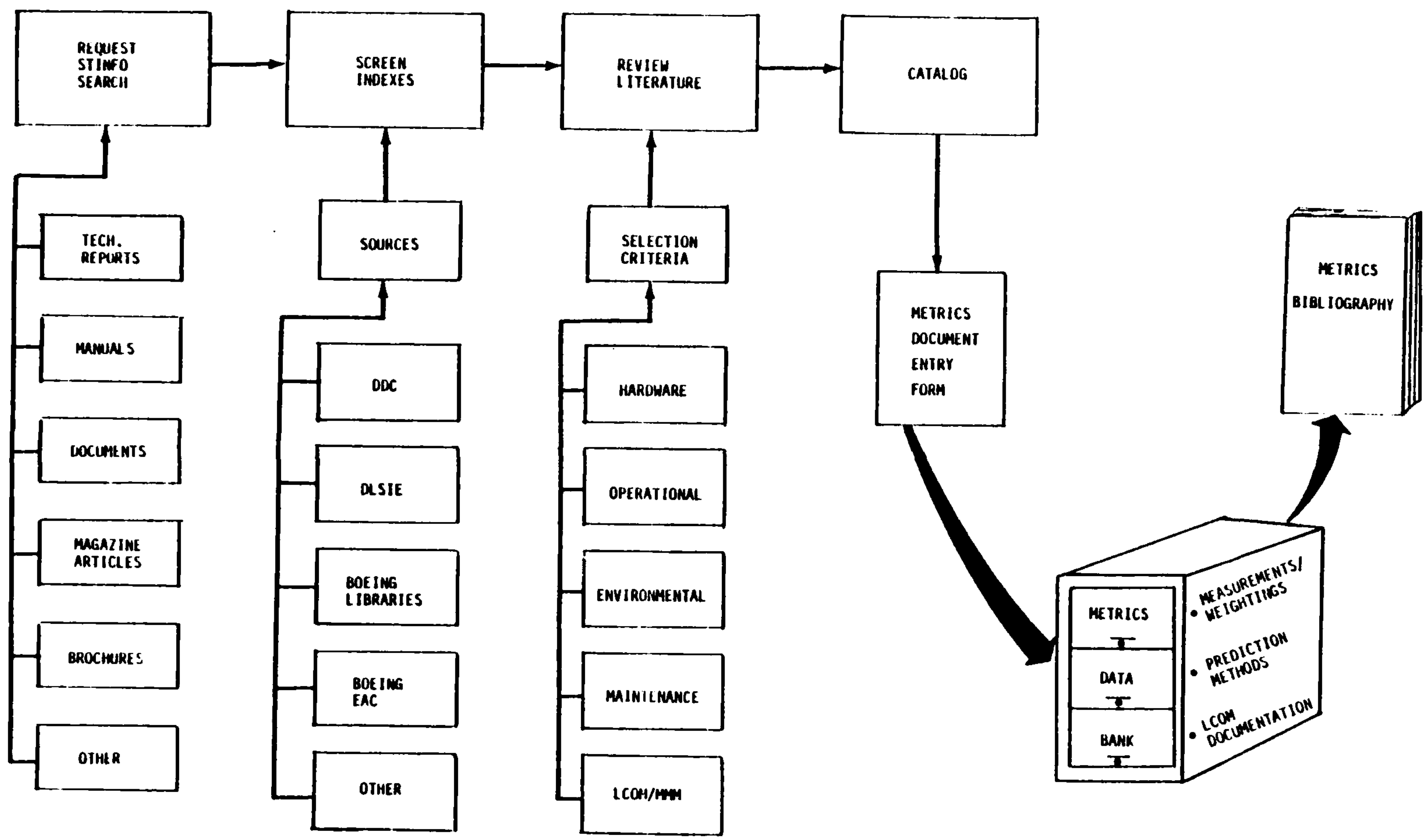


FIGURE 4 IDENTIFY, OBTAIN, AND REVIEW RELATED PUBLICATION FLOW - TASK I

4. REVIEW LITERATURE

The information was then divided into five major categories; i.e., maintenance, hardware (equipment), operational, environmental, and aircraft general. Only documents that were aircraft weapon system maintenance cause and measure/rate oriented were included in each of these categories. Also if data on LCOM/MMM was contained in the report, it was retained. Although the primary equipment areas for this phase of the study were engines and avionics, information on the remaining aircraft systems was identified and cataloged in preparation for Phase II. Over 100 reports passed this screen. For simplicity all historical information, regardless of form will be henceforth referred to as a document.

An interesting fact emerged from this literature search in that no published documents were similar or duplicated the work being done in this study.

5. CATALOGING

To aid in the retention and subsequent retrieval of the documents for analysis in future tasks, a summarized log form was developed. This form, Figure A-1, located in Appendix "A", not only provided a systematic method of building the METRICS Data File but it allowed the investigators to more efficiently screen and identify the useful content of a given document that may be required in an analysis task.

A total of seventeen fields are available on the entry form for coding/indexing the pertinent factors of a document to describe its characteristics and are also included in Appendix "A".

6. BIBLIOGRAPHY

The contents from the METRICS file was then utilized to develop the bibliography contained in this report.

7. SUMMARY

This section, pictorially represented in Figure 5, describes the five major steps in this first task; a) STINFO search, b) index screening, c) review of documents, d) cataloging, and e) the development of a bibliography.

The STINFO search produced over 1200 abstracts that were screened to 300 documents for acquisition and further study. These then resulted in a METRICS Historical File and a Bibliography of over 100 pertinent contributors to the study.

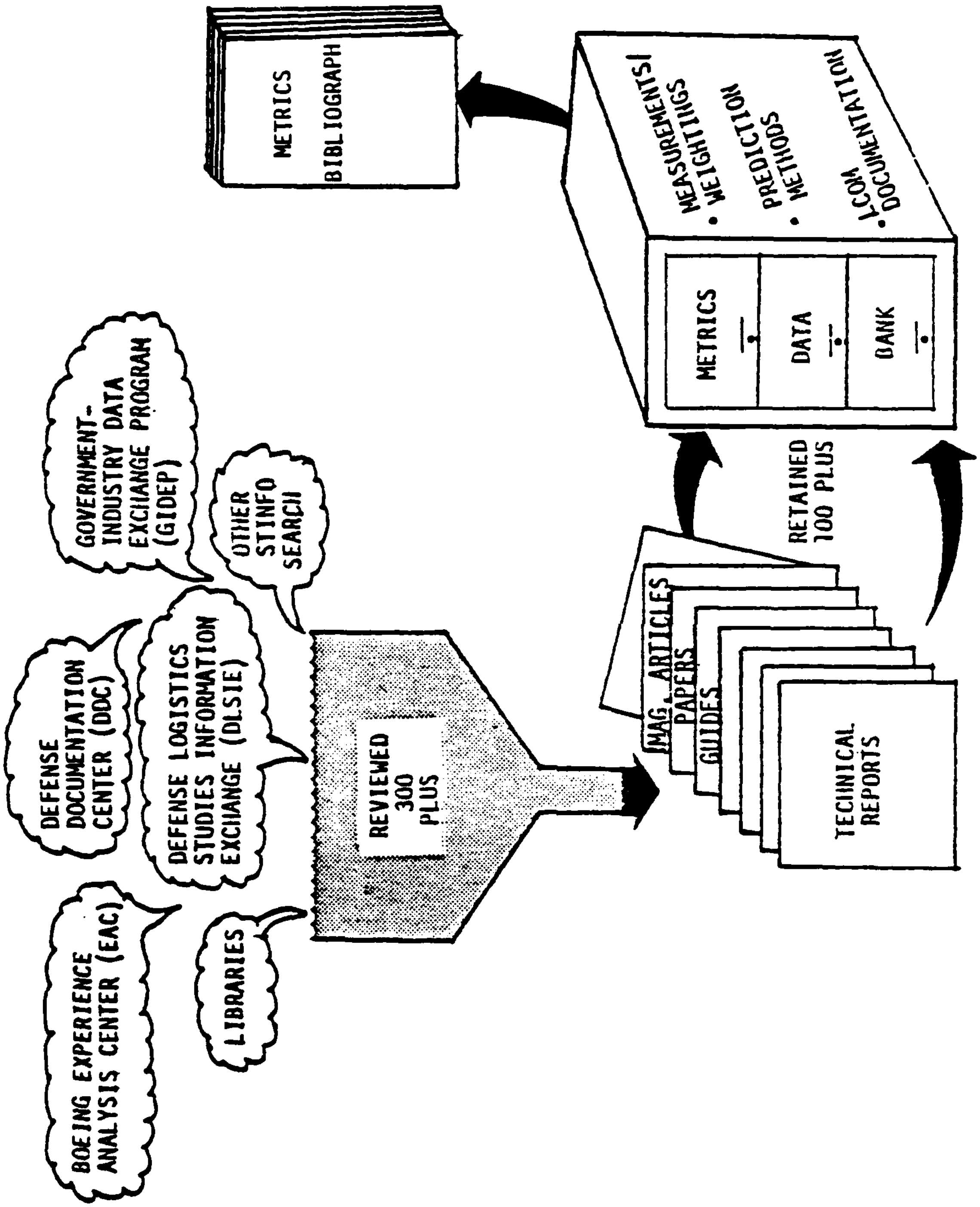


FIGURE 5 SUMMARY OF TASK I

III - SUBSYSTEM EQUIPMENT SELECTION - TASK II

1. INTRODUCTION

In order to scope the study aircraft and subsystem equipment selection to the resources and time available for the study, an examination of the subsystem equipment configurations was made across a representative population of current Air Force aircraft. This examination was limited to Air Force aircraft currently in the inventory for which current operational data was available or could be obtained from on-site visits. The subsystem equipment selection task was divided into a set of sub-tasks sequentially organized as presented in Figure 6. The following discussion details the approach and subsystem equipment selection process.

2. IDENTIFY STUDY AIRCRAFT

A preliminary list of candidate aircraft was compiled considering the following criteria:

a) Representative aircraft of various types currently in the Air Force inventory, i.e., bomber, cargo/transport, fighter, trainer, and attack.

b) Wide range of operational commands (usage) and different environments represented by selected aircraft, i.e., different missions and operating locations across various types of aircraft.

c) Wide range of subsystem applications with different complexity, packaging, and maturity represented within the selected aircraft.

d) Sufficient data sample size available for credible analysis.

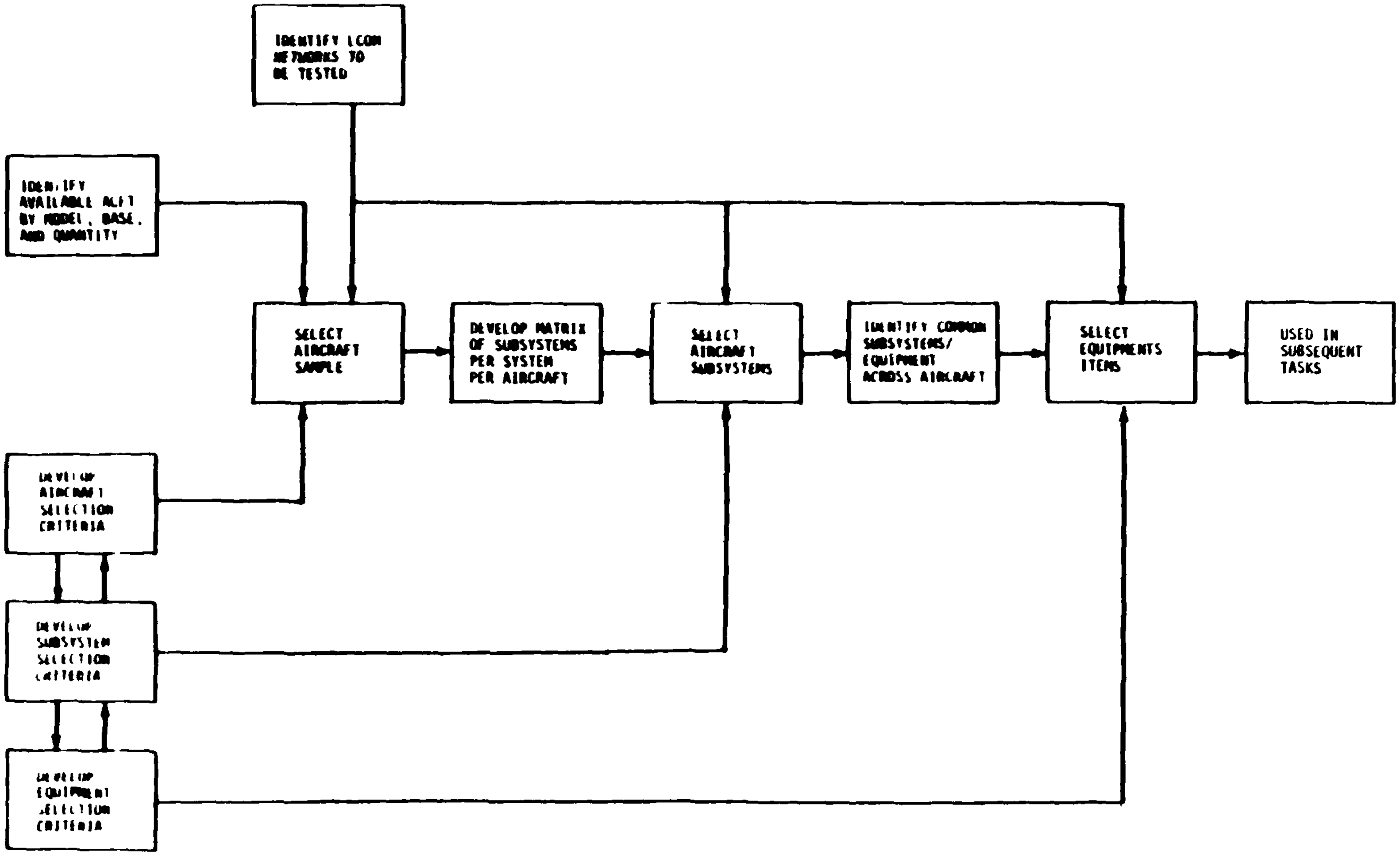


FIGURE 6 TASK II - SUBSYSTEM EQUIPMENT SELECTION ACTIVITY FLOW

The list of candidate aircraft originally compiled consisted of 14 different types of aircraft at over 30 locations, and after applying the above mentioned aircraft selection criteria the list was narrowed down to seven different types of aircraft at nine locations. Table 1 presents the selected aircraft in terms of aircraft type, model, series, and the selection criteria discussed above.

3. IDENTIFY SUBSYSTEM/EQUIPMENT SELECTION CRITERIA

The initial subsystem equipment selection criteria was developed early in the study and was expanded during the accomplishment of Task I Literature Review. The selection criteria that was utilized during the actual subsystem equipment selection process was as follows:

a) Equipment selected should be functionally representative of a wide cross-section of aircraft applications and use environments.

b) Equipment selected should represent a wide variation in type, i.e., design technology (new-old), electrical/mechanical, parts count/complexity, maturity states, testability, and usage.

c) Packaging and design technology must be projectable into the future to prevent obsolete technology from unduly biasing statistical relationships which will be used for future predictions.

d) Equipment must be mature enough for data samples to be taken beyond the learning curve period, yet include relatively new and old equipment.

e) Equipment must have a statistically valid population of operational units in use.

f) The equipment must have sufficient historical data available for valid analysis.

g) Equipment selected should represent a significant percentage of the total maintenance resources expenditure demands, i.e., maintenance manhours, failures, removals, costs, etc.

TABLE 1 STUDY AIRCRAFT/AIR FORCE BASES

AIRCRAFT					GEOGRAPHIC LOCATION					PRIMARY WX ENVIRON.				
TYPE	MDS	QTY	COMMAND	BASE	NORTH	SOUTH	EAST	WEST	EUROPE	HOT	COLD	HUMID	DRY	TYPE ENGINE
BOMBER	B-52G	16	SAC	FAIRCHILD WA	X			X			X		X	J57
BOMBER	FB-111A	31	SAC	PLATTSBURGH NY	X		X				X			TF30
CARGO	C-141A	35	MAC	TRAVIS CAL				X		X		X		TF33
TANKER	KC-135A	27	SAC	FAIRCHILD WA	X			X			X		X	J57
FIGHTER	F-15A	43	TAC	LUKE ARIZ		X		X		X			X	F100
FIGHTER	F-15A	70	AFE	BITBURG GERMANY					X		X	X		F100
ATTACK	A-10A	31	TAC	MYRTLE BEACH SC		X	X			X		X		TF34
ATTACK	A-10A	19	TAC	DAVIS-MONTHAN ARZ		X		X		X			X	TF34
TRAINER	T-38	75	ATC	RANDOLPH TEX		X				X		X		J85

h) Equipments should be of a nature for which factors other than just flying hours may contribute to their reliability/maintainability characteristics.

i) Equipment selected should fit within the functional grouping of the LCOM network to be utilized during follow-on tasks.

4. IDENTIFY SUBSYSTEM/EQUIPMENT APPLICATIONS BY TYPE AIRCRAFT

The next logical process was to develop an aircraft versus subsystem application matrix identifying all common subsystems. This was accomplished by detail review of each system in the applicable aircraft work unit code (-06) technical orders. Table 2 reflects the 476 avionics and engines subsystems identified across the seven study aircraft in Phase I and Table 3 reflects 468 other common subsystems identified on the same seven study aircraft in Phase II.

5. SELECT SUBSYSTEM EQUIPMENTS

Prior to selection of the study subsystem equipments, it was necessary to review the LCOM networks available on the seven study aircraft and determine which aircraft/LCOM network would be utilized to perform the follow-on study tasks. This was necessary to insure that selected equipments would fit functionally within the subsystem structure of the LCOM network to be utilized. This review and coordination with the AFHRL contract monitor resulted in selection of the Tactical Air Command (TAC) F-15A LCOM network.

Utilizing the 944 subsystems reflected in Tables 2 and 3, the following sequential step by step subsystem equipment selection process was accomplished:

a) First, in order to reduce the large amount (944) of subsystems down to a manageable number for the study, those systems/subsystems that showed up on less than five of the seven study aircraft were eliminated.

b) Identified all subsystems contained in the TAC F-15A LCOM network.

c) Identified the functionally equivalent subsystems or similar equipment groupings within the other six study aircraft.

TABLE 2 - SYSTEM/SUBSYSTEM COUNTS BY TYPE AIRCRAFT - PHASE I - (AVIONICS & ENGINES)

SYSTEM NUMBER	SYSTEM NAME	F-15A	B-52G	FB-111A	C-141A	KC-135	T-38	A-10	TOTAL
23	Power Plant	12	13	23	16	15	15	7	101
24	APU	5			7	4		4	20
51	Instruments	4	5	7	5	13	3	4	41
52	Autopilot	2	4	2	5	8	1	1	23
55	Malfunction Recording	3	3	1	1		2	3	13
56	Flight Reference				4				4
57	Integrated Guidance/Flt Control	1							1
61	HF Communications System		2	2	1	4			9
62	VHF Communications System				2	2	2	2	8
63	UHF Communications System	3	2	1	2	9	2	1	20
64	Interphone		1	1	3	1	2	1	9
65	IFF	2	2	1	1	1	3	1	11
66	Emergency Communications				2	8			10
69	Misc Communications			1		15		2	18
71	Radio Navigation	5	2	3	8	5	4	3	30
72	Radar Navigation		2	1	7	17		1	28
73	Bombing Navigation		7	9	2				18
74	Fire/Weapon Controls	4	5	1			2	4	16
75	Weapons Delivery	10	4	6			4	8	32
76	ECM	6	13	8		19		2	48
77	Photo Recon		9			6	1		16
	TOTALS	57	74	67	66	127	41	44	476

TABLE 3 - SYSTEM/SUBSYSTEM COUNTS BY TYPE AIRCRAFT - PHASE II - (OTHER SUBSYSTEMS)

SYSTEM NUMBER	SYSTEM NAME	F-15A	B-52G	FB-111A	C-141A	KC-135A	T-38A	A-10A	TOTAL
11	Airframe	6	14	2	9	10	8	6	55
12	Fuselage Compartment and Cockpit	4	8		6	9	2	5	34
13	Landing Gear	6	5	11	7	9	8	8	54
14	Flight Controls	6	6	8	9	5	5	8	47
16	Escape System			4					4
41	Air Conditioning, Anti Ice	2	8	4	9	11	4	7	45
42	Electrical Power Supply	6	5	3	8	2	3	7	34
44	Lighting System	3	3	6	3	3	4	3	25
45	Hyd. and Pneu. Power Supply	3	3	1	7	2	1	3	20
46	Fuel System	4	6	9	7	5	5	7	43
47	Oxygen System	1	2	1	3	1	2	1	11
49	Miscellaneous Utilities	3	6	3	7	3	1	2	25
91	Emergency Equipment	1	1		3	2	1	1	9
92	Tow Target Equipment								
93	Drag Chute Equipment		1						1
94	Meterological Equipment					4			4
95	Smoke Gen Scoring & Target Area Equip		22	8			1		31
96	Personnel Equipment			1		1	1	1	4
97	Explosive Devices and Components	1	3	4	1	1	1	5	16
98	Atmospheric Research Equipment					6			6
	TOTALS	46	93	65	79	74	47	64	468

d) Identified and listed all work unit codes (at the four or five digit level as appropriate) for each of the subsystem/equipment functional groupings identified in b and c above.

e) Determined the number of failures reported against each of the work unit codes within each of the subsystem functional groupings from b and c above.

f) Totaled the number of failures within each subsystem functional grouping and computed what percentage of the subsystem functional grouping total, the failures for each work unit code represented.

g) Selected the work unit code(s) within each subsystem functional grouping on each aircraft that represented the top failure percentage (50% or greater) of the total failures within the subsystem.

h) Compared common functions of the subsystem equipments selected on each aircraft and made minor adjustments as necessary to insure that functional equivalent or similar subsystem equipments were selected across each study aircraft.

Table 4 shows 165 individual equipment items elected in Phase I for avionics and engines and Table 5 shows the 187 equipment items selected in Phase II for the other aircraft subsystems. Tables 4 and 5 also reflect the subsystem/equipment functionally groupings across the seven study aircraft. As reflected in Table 4, all of the engine subsystems were rolled up to the two digit level of the work unit code structure and the complete propulsion system is considered as one equipment item on each aircraft. This was necessary as the F-15A LCOM network is structured utilizing the same process. All other subsystem equipments on all seven aircraft are structured at the work unit code three digit level or lower (four or five digit level). Tables 6 and 7 have been inserted to show those same 352 equipment item counts by aircraft and at the major system level. As can be seen in Tables 6 and 7, the 352 total equipments are reasonably distributed across the seven study aircraft.

TABLE 4 AIRCRAFT SELECTED EQUIPMENTS ARRAYED BY F-15A LCOM NETWORK SUBSYSTEMS AVIONICS AND ENGINES METRICS STUDY PHASE I

F-15A		B-52G		FB-111A		C-141A		KC-135A		T-38A		A-10A	
SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE
• 23	POWER PLANT (F-100)	23	POWER PLANT (J-57)	23	POWER PLANT (TF-30)	23	POWER PLANT (TF-33)	23	POWER PLANT (J-57)	23	POWER PLANT (J-85)	23	POWER PLANT (TF-34)
• 51A	FLIGHT INDICATORS												
51AD	Attitude Indicator	51AAA	Altimeter	51ABA	Altimeter, Pressure	51AAC	Altimeter, Rate of Climb	51BD	Indicator, Angle of Attack	51112	Indicator Airspeed	51CAA	Accelerometer
51AH	Altimeter, Pressure			51ABG	Attitude Indicator	51BHA	Altimeter, Pressure	51116	Indicator, Rate of Climb	51116	Altimeter	51CAC	Attitude Indicator
51AK	Attitude Indicator			51ABP	Attitude Indicator			51132	Altimeter	51216	Attitude Indicator	51CDP	Altimeter
• 51E	AIR DATA SYSTEM												
51EA	Computer, Air Data	51DAA	Pitot Static Tube	51FAA	Probe, Pitot Static	51AAA	Computer, Central Air Data	51BA	Computer, RGA	51122	Boom, Pitot Static	51CDA	Probe, Pitot Static
51ED	Transmitter, Angle of Attack	73CCA	Computer, Altitude Verticle Velocity	52BAA	Computer, Central Air Data	51AAE	Computer, Primary	51BE	Transmitter, Angle of Attack	51127	Switch, Airspeed Attitude	51CDK	Computer, Altitude
		73CCC	Computer, Heading Data	52BCC	Transmitter, Angle of Attack	51AB	Amplifier, Altimeter			6131A	Computer, Angle of Attack	51CGA	Transmitter, Angle of Attack
		73CCG	Computer, Airspeed										
• 51H	HORIZONTAL SITUATION INDICATING												
51HA	Indicator, Horizontal Situation	71AFJ	Indicator, Horizontal Situation	51ABE	Indicator, Horizontal Situation	51BGA	Computer, Flight Director	51AAD	Indicator, Horizontal Situation	51213	Indicator, Horizontal Situation	51GA	Indicator, Horizontal Situation
51HB	Flight Director, Adapter	71AFK	Computer, Flight Director	51BAF	Computer, Flight Director	51BGK	Indicator, Horizontal Situation	51AC	Computer, Roll			63AD	Direction Finder
								51AD	Computer, Pitch				

• F-15A LCOM NETWORK SUBSYSTEMS

TABLE 4 CONT'D

AIRCRAFT SELECTED EQUIPMENTS ARRAYED BY F-15A LCOM NETWORK SUBSYSTEMS
AVIONICS AND ENGINES
METRICS STUDY PHASE I

F-15A SUB SYSTEM WUC	F-15A NOMENCLATURE	B-52G SUB SYSTEM WUC	B-52G NOMENCLATURE	FB-111A SUB SYSTEM WUC	FB-111A NOMENCLATURE	C-141A SUB SYSTEM WUC	C-141A NOMENCLATURE	KC-135A SUB SYSTEM WUC	KC-135A NOMENCLATURE	T-38A SUB SYSTEM WUC	T-38A NOMENCLATURE	A-10A SUB SYSTEM WUC	A-10A NOMENCLATURE
* 52A	AUTO PILOT												
52AA	Computer, Flight Control CP-1104	52AAD	Selector, Command	52AAA	Computer, Flight Control - Roll	52AAC	Auto Flight Controls Gyro-Two Axis-Rate	5211	Amplifier, MC-1	52111	Airspeed Compensator	52AA	Computer, Stability Augmentation
		52AAB	Amplifier, Main					52113	Coupler, Dual Channel				
52AB	Computer, Flight Control CP-1105	52AAK	Servo, Follow-up	52ABA	Computer, Flight Control - Pitch	52AAJ	Auto Flight Controls Gyro-Vertical			52117	YAW Axis Actuator	62AC	Control Panel Aux. Flight
		52ABX	Servo, Control					5214	Gyro, Roll and Pitch Displacement	52118	Valve Servo, YAW Axis Actuator		
				52ACA	Computer, Flight Control - YAW	52ACD	Rudder, Gyro Single-Axis-Rate	5212	Servo, Aileron	52121	Calibration Module		
				52ADA	Feel Trim Assy.			5212	Servo, Rudder				
								5212	Servo, Elevator				
* 63A	UHF COMM SET												
63AA	Receiver Transmitter R/T-967/ARC-109	63BAA	Receiver-Transmitter AN/ARC-34	63AA	Receiver-Transmitter R/T-749/ARC-109	63AAE	Control C-3894/A	63AF	Receiver-Transmitter ARC-133/ARC-34	63AA	Receiver-Transmitter R/T-463, 760, 263	63AA	Receiver-Transmitter ARC-164
63AG	Receiver, R-1789/ARC-109	63BBA	Control C-1067	63AB	Control ARC-109	63AB	Receiver-Transmitter R/T-641/ARC-90	63AH	Control C-1057				
* 65A	TRANSPONDER SET												
65AA	Receiver-Transmitter R/T 1063B/APX-101	65BAA	Receiver-Transmitter R/T-726/APX-64	65AA	Receiver-Transmitter R/T-728/APX-64	66BB	Receiver-Transmitter R/T-721	65BAA	Receiver-Transmitter R/T-726/APX-64	65CA	Receiver-Transmitter R/T-727	65A	Transponder Set APX-101
		65BBB	Computer, Transponder			65BC	Test Set - Transponder	65BBL	Computer, Transponder	65CBB	Control - 6280		

* F-15A LCOM NETWORK SUBSYSTEMS

TABLE 4 CONT'D

AIRCRAFT SELECTED EQUIPMENTS ARRAYED BY F-15A LCOM NETWORK SUBSYSTEMS
AVIONICS AND ENGINES
METRICS STUDY PHASE I

F-15A		B-52G		FB-111A		C-141A		KC-135A		T-38A		A-10A	
SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE
* 71A	INERTIAL NAVIGATION SET												
71AE	Inertial Measurement Unit			73HA	Stabilizer, Platform, Inertial Nav Set	73BA	Inertial Navigation Unit			71ABA	Antenna		
71AK	Control, Indicator Nav			73HC	Computer, Navigational	73BB	Display Control						
* 71L	INSTRUMENT LANDING SET												
71CA	Receiver R-1755/ARN	71ABC	Receiver ARN-31	71CA	Receiver R-843A/ARN-58	71EAB	Receiver 800B	71AAA	Receiver	71BA	Receiver R-843		
		71ACC	Receiver ARN-32	71CB	Receiver R-844A/ARN-58	71EAC	Receiver 51V-4	71BCF	Receiver 51V-4	71BB	Receiver R-844		
* 71D	TACAN SET												
71DA	Receiver-Transmitter R/T-1045/ARN	71ADA	Receiver-Transmitter ARN-21	71EA	Receiver-Transmitter R/T-1127/ARN-84	71CB	Receiver-Transmitter R/T-220C	71CA	Receiver-Transmitter ARN-21/72	71CA	Receiver-Transmitter R/T-471	71AF	Receiver-Transmitter
												71AJ	Control Panel
* 71F	ATTITUDE HEADING REFERENCE SET												
71FA	Amplifier, Electrical Control	51AND	Gyro, Roll and Pitch	51CAC	Gyroscope, Displacement	52FA	Gyroscope, Displacement	51142	Gyroscope, Displacement	5121A	Amplifier Servo	51FA	Gyroscope, Displacement
71FB	Gyroscope, Displacement	51ANB	Attitude Indicator	51CC	Amplifier Electrical Control	52FB	Amplifier Electrical Control			5121B	Platform Gyro	61FC	Amplifier Electrical Control

* F-15A LCOM NETWORK SUBSYSTEMS

TABLE 4 CONT'D
AIRCRAFT SELECTED EQUIPMENTS ARRAYED BY F-15A LCOM NETWORK SUBSYSTEMS AVIONICS AND ENGINES METRICS STUDY PHASE I

F-15A		B-52G		FB-111A		C-141A		KC-135A		T-38A		A-10A	
SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE
* 74F	RADAR SET												
74FA	Transmitter T-1200	73CFK	Receiver-Transmitter	73JC	Modulator, Radar	72AD	Receiver-Transmitter R/T-2090	72MAA	Receiver-Transmitter R/T-289			72AA	Encoder-Transponder R/T-855
74FC	Receiver R-1765	73CGA	Modulator, Radar	73JE	Indicator-Recorder	72AK	Power Supply - 1073	72MFA	Indicator Azimuth Range			72AB	Antenna
74FH	Power Supply PP-6602	73CGP	Computer	73JM	Synchronizer	72AL	Antenna						
74FQ/FR	Processor MX-9099					72AM	Synchronizer						
74FS	Processor MX-9100												

* F-15A LCOM NETWORK SUBSYSTEMS

TABLE 5

AIRCRAFT SELECTED EQUIPMENTS ARRAYED BY F-15A LCOM NETWORK SUBSYSTEMS
AIRCRAFT SYSTEMS OTHER THAN AVIONICS AND ENGINE
METRICS STUDY PHASE II

F-15A		B-52G		FB-111A		C-141A		KC-135A		T-38A		A-10A	
SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE
11A	FORWARD FUSELAGE												
11AB	Radome Assy.	11H[illegible]	Radome Assy.	11AAA	Radome Assy.	11FAI	Radome Assy.	1111J	Radome Assy.				
11AE	Windshield	11H[illegible]	Windshield	16AA	Windshield	11AA	Windshield	1114H	Windshield	111	Windshield	11AI	Windshield
11B	WINGS												
11K	Wings	11A	Wing, Outboard	11B	Wings	11G	Wings (Excluding 11GE Pylons)	11A	Wing and Strut Midspar	116	Wings	11Q	Wings
		11B	Wing, Inboard	11EFA	Wing, L.H. Upper Skin			116	Wing Assy. L.H.				
		11C	Wing, Center	11EFB	Wing, L.H. Lower Skin			117	Wing Assy. R.H.				
				11EFC	Wing, R.H. Upper Skin			11J	Wing Skin R.H.				
				11EFD	Wing, R.H. Lower Skin			11K	Wing Skin L.H.				
								11L	Center Wing Pressure Webbing				

TABLE 5
CONT'D

AIRCRAFT SELECTED EQUIPMENTS ARRAYED BY F-15A LCOM NETWORK SUBSYSTEMS
AIRCRAFT SYSTEMS OTHER THAN AVIONICS AND ENGINE
METRICS STUDY PHASE II

F-15A		B-52G		FB-111A		C-141A		KC-135A		T-38A		A-10A	
SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE
120	COCKPIT FURNISHINGS												
120AA	Seat, Aircraft Ejection, Crew	12AAA	Seat Assy. Upward Ejection, Crew	16AGA	Seat, Crew	12BAA	Seat, Pilot and CoPilot	12AAO	Seat, Crew	12121	Seat Assy. Ejection Front Cockpit	12KAO	Seat Assy. Ejection, Crew
										12221	Seat Assy. Ejection Rear Cockpit		
13A	MAIN LANDING GEAR												
13AJA	Tire, Main	13CGB	Tire, Main	13GAH	Tire, Main	13GAC	Tire, Main	13AHF	Tire, Main	13831	Tire, Main	13AHA	Tire, Main
13AJN	Wheel, Main	13CGA	Wheel, Main	13GAA	Wheel, Main	13GAA	Wheel, Main	13AHG	Wheel, Main	13811	Wheel, Main	13AHG	Wheel, Main
13D	BRAKE SUBSYSTEM												
13DB	Brake, Assy.	[illegible]	Brake, Assy.	13JAG	Brake, Assy.	13DBA	Brake, Assy.	13CA	Brake, Assy.	13611	Brake, Assy.	13HA	Brake, Assy.

TABLE 5 CONT'D

AIRCRAFT SELECTED EQUIPMENTS ARRAYED BY F-15A LCOM NETWORK SUBSYSTEMS
AIRCRAFT SYSTEMS OTHER THAN AVIONICS AND ENGINE
METRICS STUDY PHASE II

F-15A		B-52G		FB-111A		C-141A		KC-135A		T-38A		A-10A	
SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE
14C	STABILATOR SUBSYSTEM												
14CA	Horiz. Stabilator	14DEA	Horiz. Stabilizer	14C	Horiz. Stabilizer	11HC	Horiz. Stabilizer	11S1	Horiz. Stab. Assy.	1421	Horiz. Tail	11EA	Horiz. Stabilizer
		14DH	Horiz. Stabil. Upper Skin			11HD	Horiz. Stabil. Skin	11G	Horiz. Stab. Skin				
		14DJ	Horiz. Stabil. Lower Skin										
		14DN	Horiz. Stabil. Rib & Spar										
14D	RUDDER SUBSYSTEM												
14DA	Rudder Assy.	14DGA	Rudder Assy.	14AD	Rudder Assy.	14CA	Rudder Assy.	148F	Rudder Assy.	1431	Rudder Assy.	14GA	Rudder Assy.
14E	FLAP SUBSYSTEM												
14EA	Flap Assy	14EE	Flap, Inboard Wing	14DC	Flap Assy.	14GA	Flap Assy.	14EF	Main Flap Assy. Inboard	1451	Flap Assy.	14KA	Flap Assy. Inboard
		14FH	Flap, Outboard Wing					14EG	Main Flap Assy. Outboard			14KB	Flap Assy. Outboard

TABLE 5
CONT'D

AIRCRAFT SELECTED EQUIPMENTS ARRAYED BY F-15A LCOM NETWORK SUBSYSTEMS
AIRCRAFT SYSTEMS OTHER THAN AVIONICS AND ENGINE
METRICS STUDY PHASE II

F-15A		B-52G		FB-111A		C-141A		KC-135A		T-38A		A-10A	
SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE
41A	CABIN AND AVIONICS ENVIRONMENTAL CONTROL SUBSYSTEM												
41AAM	Water Separator	41ADA	Water Separator	41ABE	Water Separator	41AEC	Water Separator	41214	Water Separator	41133	Water Separator	41BAI	Water Separator
						41AEA	Water Separator						
42A	AIRCRAFT POWER GENERATING SUBSYSTEM												
42ADA	Generator Assy.	42BAA	Generator Assy.	42AAA	Generator Assy.	42DAA	Generator Assy.	4215L	Generator Assy.	4211A	Generator Assy Lt.	42AC	Generator Assy.
										4212A	Generator Assy Rt.		
44A	EXTERIOR LIGHTING												
44AAA	Tail Anti Coll.	44AAA	Anti Coll Lights	44AAJ	Anti Coll Lights Upper	44AAE	Anti Coll Lights	4426	Anti Coll Lights	44113	Anti Coll Lights Upper	44BAA	Wing Position & Strobe Lights R&L
44AAD	Light Nav Anti Coll Right Wing			44AAK	Anti Coll Lights Lower					44116	Anti Coll Lights Lower	44BAB	Tail Position & Strobe Lights
44AAZ	Light Nav Anti Coll Left Wing												
44AAJ	Light Landing	44AEA	Light Landing	44AAD	Light Landing	44AAC	Light Landing	44211	Landing Light	44114	Landing and Taxi Light	44BF	Landing and Taxi Light
44AAL	Light Taxi	44ADA	Light Taxi	44AAA	Light Taxi	44AAD	Light Taxi	44212	Taxi Light				

TABLE 5 CONT'D

AIRCRAFT SELECTED EQUIPMENTS ARRAYED BY F-15A LCOM NETWORK SUBSYSTEMS
AIRCRAFT SYSTEMS OTHER THAN AVIONICS AND ENGINE
METRICS STUDY PHASE II

F-15A		B-52G		FB-111A		C-141A		KC-135A		T-38A		A-10A	
SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE
45A 45B	HYDRAULIC POWER CONTROL SUBSYSTEM												
45AEE	Pump Hydraulic PC#1	45CBN	Pump Hydraulic	45AAA	Pump Hydraulic	45ACA	Pump Hydraulic	4511E	Pump Hydraulic	45121	Pump Hydraulic	45AAA	Pump Hydraulic
45BEE	Pump Hydraulic PC#2	45CCJ	Pump Hydraulic	45AAW	Pump Hydraulic	45BCA	Pump Hydraulic	45118	Pump Hydraulic	45122	Pump Hydraulic	45BAA	Pump Hydraulic
46A	INTERNAL FUEL SUBSYSTEM												
11KEA	Fuel Tank L.H. Wing	46EAA	Tank Main Wing	46HAG	Saddle Tank R.H.	46AAJ	Tank Main #1 or 4	46130	Tank Main #1	46123	Cell Fwd Fuselage	46AC	Main Tank L. Wing
11KFA	Fuel Tank R.H. Wing												
46AE	Fuselage Fuel Cells	46EBA	Tank Outboard Wing	46HAH	Saddle Tank L.H.	46AAK	Tank Main #2 or 3	46170	Tank Main #2	46124	Cell Cent Fuselage	46AD	Main Tank R. Wing
		46ECA	Tank Center Wing	46HAE	Tank Integral Bay A-1			46210	Tank Main #3	46125	Cell Aft Fuselage		
				46HAF	Tank Integral Bay A-2			46240	Tank Main #4				
								46310	Tank Center Wing Left Hand				
								46340	Tank Center Wing Right Hand				

TABLE 5 CONT'D

AIRCRAFT SELECTED EQUIPMENTS ARRAYED BY F-15A LCOM NETWORK SUBSYSTEMS
AIRCRAFT SYSTEMS OTHER THAN AVIONICS AND ENGINE
METRICS STUDY PHASE II

F-15A		B-52G		FB-111A		C-141A		KC-135A		T-38A		A-10A	
SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE	SUB SYSTEM WUC	NOMENCLATURE
47A	LIQUID OXYGEN SUBSYSTEM												
47AAH	Regulator Oxygen	47ALA	Regulator Oxygen	47AAC	Regulator Oxygen	47AAG	Regulator Oxygen	47131	Regulator Oxygen	47115	Regulator Oxygen	47ABA	Regulator Oxygen
47AA[illegible]	Converter Lox	47AAA	Converter Lox	47AAA	Converter Lox	47AAA	Converter Lox	47111	Converter Lox	47111	Converter Lox	47AAD	Converter Lox
49A	OVERHEAT/FIRE DETECTION AND EXTINGUISH SUBSYSTEM												
49AA	Engine Overheat & Fire Detection System	49BAD	Detector Engine Fire	49AAA	Element Assy. Sensing (Nacelle) Fire Detection	49FAB	Sensing Element Engine Fire	49421	Detector Fire	49111	Sensor Engine Fire	49AAB	Sensor 650 Degrees
										49111	Sensor Engine Fire	49AAC	Sensor 500 Degrees

TABLE 6 - EQUIPMENT/ITEMS BY AIRCRAFT/SYSTEM PHASE I AVIONICS AND ENGINES

SYSTEM		AIRCRAFT							
		F-15A	B-52G	FB-111A	C-141A	KC-135A	T-38A	A-10A	TOTAL
23	Propulsion	1	1	1	1	1	1	1	7
51	Instruments	7	4	8	7	9	9	9	53
52	Autopilot	2	4	6	5	6	4	2	29
63	UHF Communications	2	2	2	2	2	1	2	13
65	IFF	1	2	1	2	2	2	1	11
71	Radio Navigation	6	5	3	3	3	4	2	26
72	Radar Navigation	--	--	--	4	2	--	2	8
73	Bomb Navigation	--	6	5	2	--	--	--	13
74	Fire Control	5	--	--	--	--	--	--	5
	TOTAL	24	24	26	26	25	21	19	165

6. SUMMARY

The subsystem/equipment selection process as depicted in Figure 6 resulted in the selection of seven study aircraft and 352 specific subsystem equipments to be studied during the study. These equipments were used as the subjects of the parametric maintenance resource demand follow-on analysis. They were selected to represent a wide variation in equipment types, design technology, parts size, complexity, maturity states, usage in different aircraft/mission types and operational and environmental conditions.

IV - PARAMETER IDENTIFICATION - TASK III

1. INTRODUCTION

The identification and screening process for potential maintenance demand/impact parameters associated with the applicable subsystem equipments selected during Task II is reflected in Figure 7. The identification and selection of appropriate parameters for use in Task V - Data Analysis/ Parameter Prioritization and Task VI - Maintenance Metrics Development required detail review of the parameters identified in other related studies to determine various parameters used, types of input variables required and availability/location of the actual required input data.

2. PARAMETER IDENTIFICATION

The investigation and identification of appropriate parameters relied heavily upon the previous work conducted during Task I - Review of Related Publications and Task II - Subsystem Equipment Selections. These related study documents were reviewed and all potential study parameters identified for each of the following five major categories: (1) Maintenance, (2) Hardware, (3) Operational, (4) Environmental, and (5) Aircraft General.

The actual parameters identified and selected for each of the five major categories are listed and defined in Tables B-1 through B-8 located in Appendix B of this document.

3. SUMMARY

The parameter identification task resulted in 193 significant, collectable parameters being selected for this Phase I (Avionics and Engines) analysis effort. The type of parameters and number for each type is as follows:

TYPE OF PARAMETERS	NUMBER SELECTED
Maintenance	30
Hardware	
Avionics	27
Engines	24
Other Systems	30
Operational	35
Environmental	31
Aircraft General	16
TOTAL	193

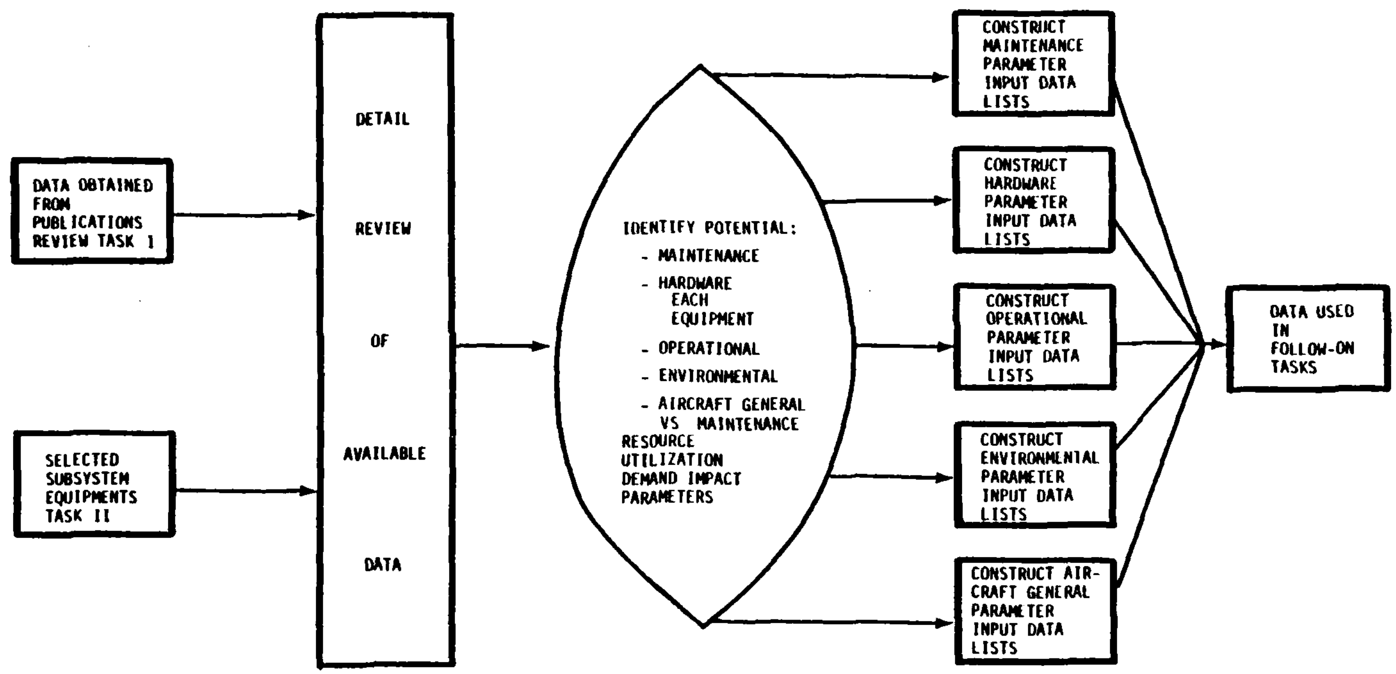


FIGURE 7 - TASK III PARAMETER IDENTIFICATION ACTIVITY FLOW

V - IDENTIFICATION AND INTEGRATION OF DATA SOURCES - TASK IV

1. INTRODUCTION

This task was by far the most critical and significant for this phase of the study. Without adequate and correct data, the remaining tasks would be less meaningful as would any analysis effort that employed a computer model. Therefore, additional emphasis was placed on this task to insure the accomplishment of the objectives.

The total task was logically divided into three distinct sub-tasks; a) Identification, b) Acquisition, and c) Integration. Figure 8 depicts the step-by-step functional flow developed and the sub-indentures of each step.

2. IDENTIFICATION

The identification of data sources and the types of data each was responsible for, or was the historical repository of, covered three primary areas; a) Air Force Agencies b) Operating Wings, and c) EAC Historical Data Files. Table 5, "Data Sources and Agencies" lists the major command, center or base; geographical location; specific office or wing data was obtained from; and the general type of available data. The various categories of information and detail data elements were established in the preceding task.

3. ACQUISITION

Once the various sources and their respective types of data had been established the next logical step was to obtain data that was not currently in the EAC Historical Data Bank or to obtain an update of more current information. Since this study was initiated in early 1978, the most recent data that would be available from the various repositories was 1977. Therefore, it is significant to note this time period as many of the parameters used in the study fluctuate with time. This is dramatically portrayed in Reference 1 on the C-130E aircraft since many of the same data elements are common.

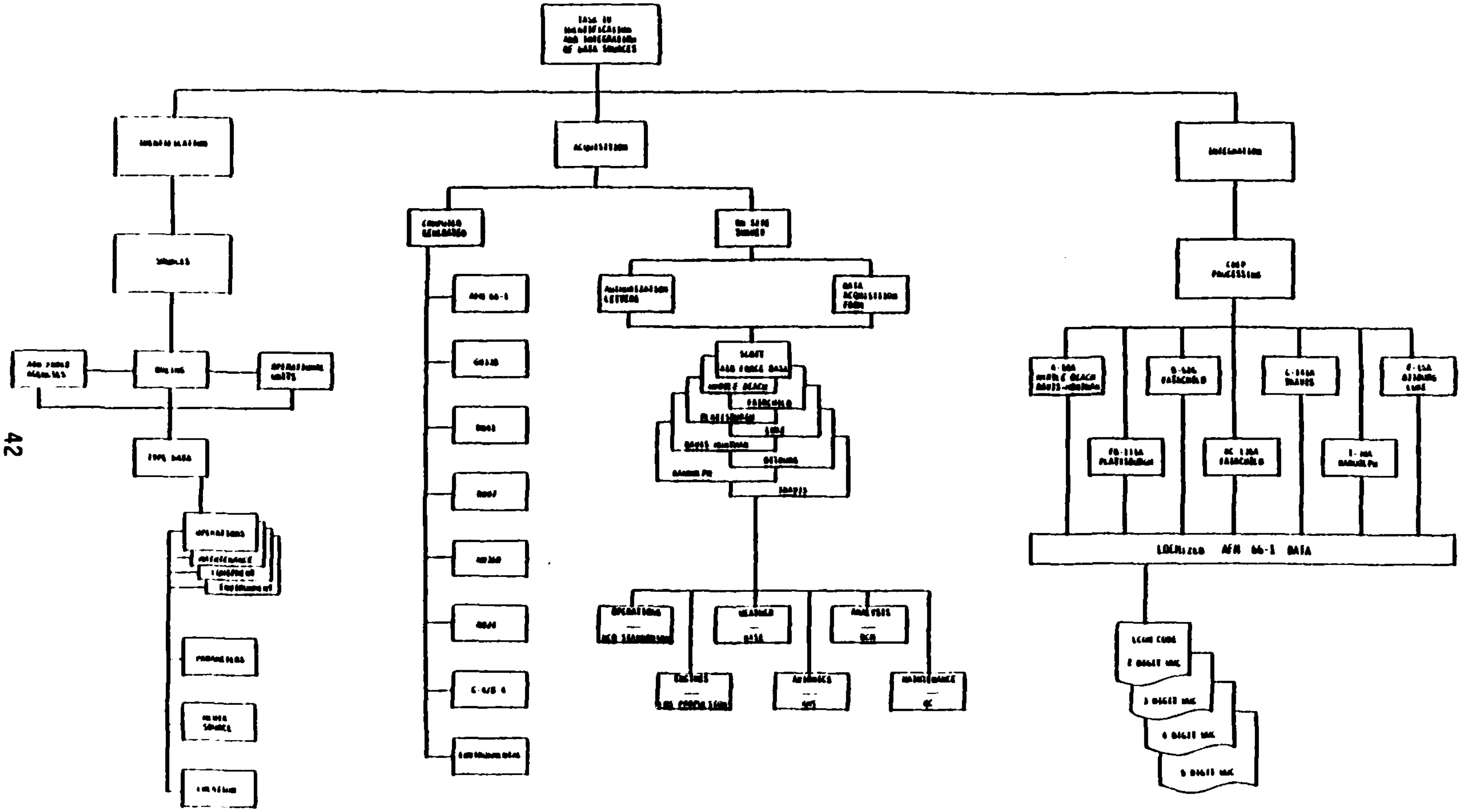


FIGURE 8 IDENTIFICATION AND INTEGRATION OF DATA SOURCES - TASK IV - FLOW DIAGRAM

TABLE 8 DATA SOURCES AND AGENCIES

AGENCY BASE	LOCATION	OFFICE SYMBOL/FUNCTION OR WING	TYPE OF DATA
Air Force Logistics Command	Wright-Patterson AFB Ohio	ACVMP - Inventory, Status and Performance Branch	D056E G033B C-4, B-4 D097
		LORRA - Analysis Branch DCS/ Logistics Operations	D041
		ACFCS - Comptroller	H036B
Air Force Maintenance and Supply Management Engineering Team	Wright-Patterson AFB Ohio	AFMSMET/(MENT) - Management Engineering Team	LCOM Users Guide LCOM Data Extraction Program Users Document
Air Weather Service (MAC) Environmental Technical Applications Center (ETAC)	Scott AFB, Ill.	ETAC/DO - Director Operations	Weather Parameters Climatic Briefs Monthly Summaries Base Tab "A's"
Myrtle Beach AFB	Myrtle Beach, S.C.	354th TFW	A-10A Statistics
Fairchild AFB	Spokane, Wash.	92nd BMW	B-52G/KC-135A Statistics
Plattsburgh AFB	Plattsburgh, N.Y.	380th BMW	FB-111A Statistics
Luke AFB	Glendale, Ariz.	58th TTW	F-15A Statistics
Davis-Monthan AFB	Tucson, Ariz.	355th TFW	A-10A Statistics
Bitburg AB	Bitburg, Germany	36th TFW	F-15A Statistics
Travis AFB	Fairfield, Calif.	60th MAW	C-141A Statistics
Boeing Aerospace Company	Seattle, Wash.	Experience Analysis Center (EAC)	Aircraft Historical Data Processed AFM 66-1 Maintenance Data Operational Data Technical Descriptive Information
Air Force Inspection and Safety Center (AFISC)	Norton AFB, Calif.	AFISC/SER	Aircraft Mishap Data (Accident/Incident)

In obtaining the specific data types, the task logically divided into computer generated type information and data that must be obtained from an on-site survey.

4. COMPUTER GENERATED DATA

Although all the data obtained in this study was eventually computer manipulated, in one form or another, at this point it was considered as data received on magnetic tape.

AFM 66-1 (D056E) - Maintenance Management Data

For the seven study aircraft all AFM 66-1 data had been previously processed for 1977 except the T-38A. This had to be ordered through the Air Force Systems Command (AFSC) via AFLCR/AFSCR 178-6 and processed. A total of over five million records or maintenance transactions were either previously available or obtained on the subject aircraft.

The specific parameters obtained from these data were discussed in Task II and are shown in the hardware parameter identification tables contained in Appendix B.

G033B - Standard Aerospace Vehicle Inventory, Status and Utilization Reporting System.

This system provided the operational parameters necessary for various rates, such as maintenance manhours per flight hour, utilization, etc. as well as the operational ready and not operational ready rates per specific categories. These and other operational parameters are shown in the operational parameter identification table contained in Appendix B.

D041 - Recoverable Consumption Item Requirements System

D097 - Interchangeability and Substitution Data Maintenance System

H036B - DMIF Cost Accounting/Production Report

These three data systems comprised the depot data used in various trades made during equipment selection and verification. The two million plus records contained such significant parameters as equipment cost, maintenance flow time through base and depot, and maintenance manhour expeditures.

B-4/C-4 - Reference Data Tape

These tapes, although not supplying any investigative parameters per se, are critical in tracking a given aircraft component from AFM 66-1 to depot data. Since they contain cross references to part number, work unit code, and national stock number.

Environmental

This information, obtained from ETAC, represents the computerized weather information for each of the eight bases visited. These included such parameters as snow fall, rain days, humidity, etc. Table B-5 in Appendix B lists all of the environmental parameters utilized in the study.

5. ON-SITE SURVEY

As in any data acquisition task of this magnitude, all the necessary parameters have not been computerized. This necessitates on-site visits to obtain the data. Not only does it fill in the missing parameters but it serves to validate the processed data. An equally important function is the establishment of data parameter specialists or points of contact that can be consulted with during the detail analysis of the data.

6. AUTHORIZATION LETTER

To visit any operational unit, authorization was required from the respective command. Appendix C shows a typical letter used that included the following pertinent items:

a) Contract Number and Name
b) Introduction
c) Objective
d) Assistance required and point of contact
e) Authorizing signatures

It is imperative that these be forwarded well in advance of the intended time of visit to allow for any contingencies that may occur at the base. Not only did this procedure work satisfactorily throughout the entire study but the points of contact were contacted immediately, once known, and again a week prior to the visit. This personal contact eliminated any last minute problems and established an excellent rapport with the base personnel.

7. DATA ACQUISITION FORM

Prior to traveling to any base a series of forms, Appendix D, were developed listing the specific data parameters desired by function, i.e., avionics, engines, etc. These forms proved to be invaluable in that they provided a consistent, systematic approach at each base. These were distributed to the respective technicians, where practical, and proved to be the most economical and expeditious method to gather all the data.

8. BASE VISITS

At each base as depicted in Figure 9, it was necessary to visit seven major areas. The first and most significant was the DCM Office. Here a short introductory presentation was given to all functional OIC's/NCOIC's from which data was required. This one time meeting set the stage for a smooth transition of data flow with all concerned namely:

- a) Operations - The DCO or standarization pilot covered the aircraft characteristics.
- b) Weather - Base weather provided obstructions to vision by month.
- c) Analysis - Monthly maintenance summaries and support general data via a BLIS printout.
- d) Engines - FMS and Propulsion covered this area.
- e) Avionics - AMS provided the data for all equipments.
- f) Other Systems -
- g) Maintenance - QC answered general type questions on aircraft maintenance.

9. INTEGRATION

This third and final major step of Task IV was primarily a continuation of data preparation for analysis in the ensuing tasks. The AFM 66-1 maintenance expenditure records (D056E) had to be screened and integrated into an LCOM acceptable format.

To accomplish this screening, computer programs were written to manipulate the data per the Common Data Extraction Program (CDEP) User Documentation (Reference [12]) specification. This criteria was followed, without deviation, since it would provide the same data base as is currently being used by LCOM analysts.

[12] "Common Data Extraction Program (CDEP)" AFMSMET, March 1978

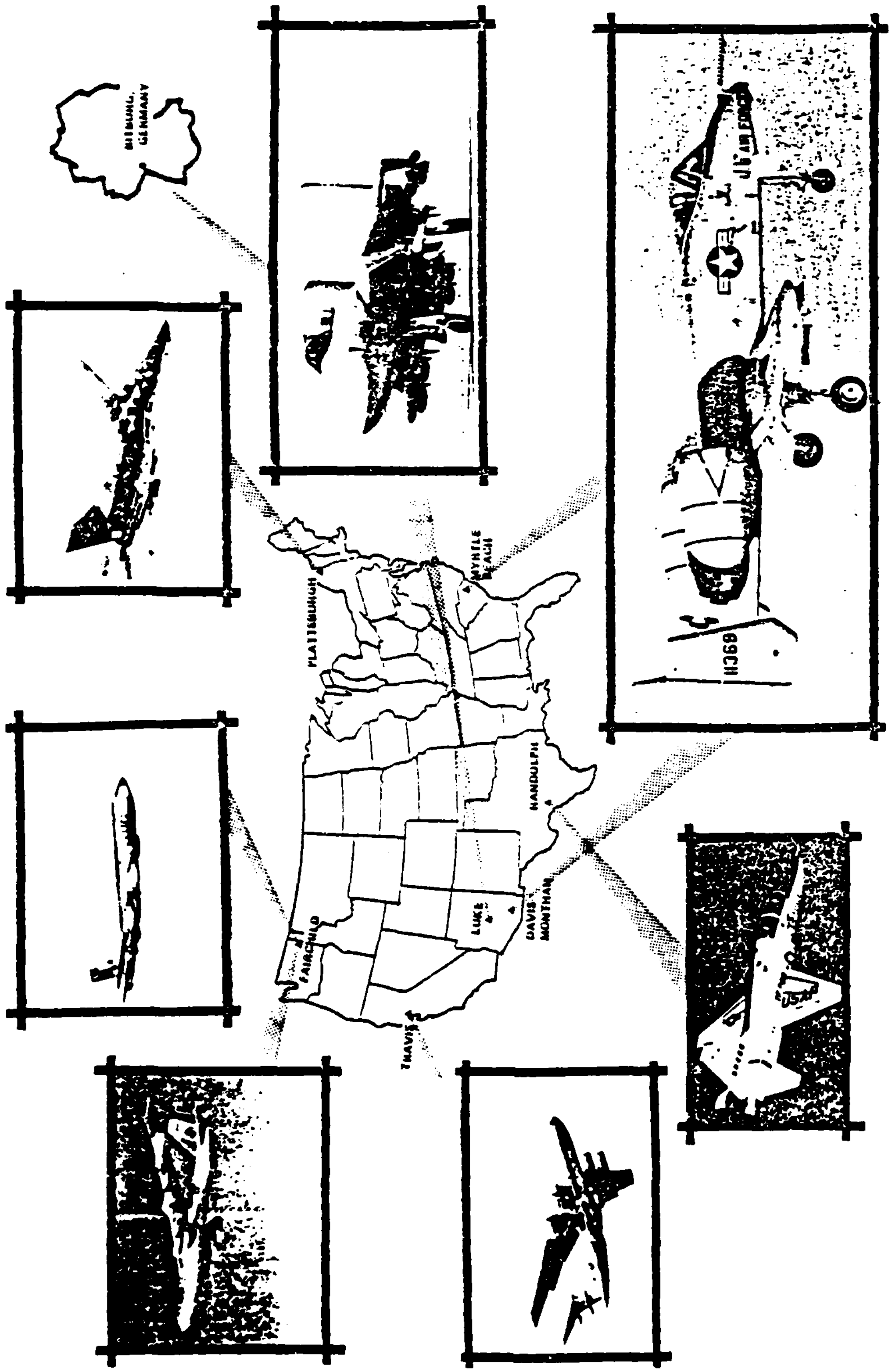


FIGURE 9 BASES VISITED

Although these Boeing developed LCOM data programs used CDEP criteria the output format was unique to the requirements of this study. Each 'LCOM Action Code' (Reference [12]), was displayed by study aircraft with the following data elements.

a) WUC at all indentures, (2, 3, 4, 5)
b) Units produced count
c) JCN count (summation of different JCN's)
d) Manhours
e) Clockhours

Table 6 is a graphical display of these indentured LCOM type actions for the F-15A at Luke AFB.

The complete procedures developed consisting of 12 subsystems and seven sort modules are described in detail along with flow charts in Boeing Document BCS-G1109, "CDEP Production System" (Reference [13]).

This processing of AFM 66-1 data for the seven different aircraft types commenced with approximately seven million records. Selecting only the data for the study aircraft at the bases visited, reduced the count to approximately 1.4 million records. Also, the flight time and number of aircraft in the data sample was reduced from 826,823 flight hours and 1,695 aircraft to 135,835 and 362 respectively.

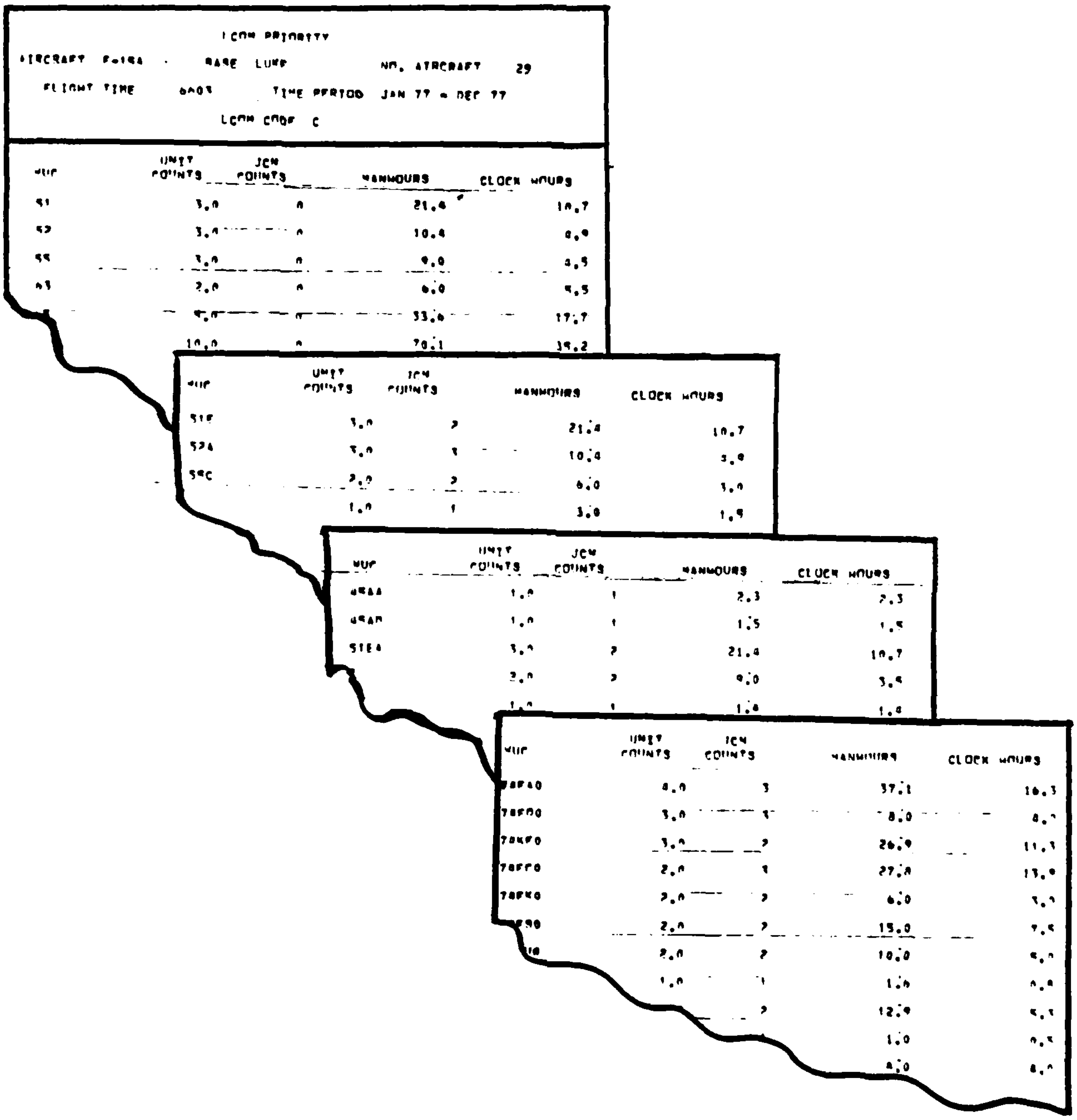
Completion of this data processing for each aircraft at each base and the supplemental data obtained from the acquisition phase (letters and on-site visits) provided a substantial data base of varied parameters for the follow-on task analyses.

10. SUMMARY

This section describes: a) identification of data sources, location, and type data available, b) acquisition of computer generated and base survey data, and c) processing AFM 66-1 data into an LCOM usable format. Over seven million maintenance transactions (records) were obtained from nine different data systems and over 400 supplemental data parameters acquired directly from on-site visits to eight operational bases. AFM 66-1 (D056E) data for seven aircraft was processed per LCOM criteria into easily readiable multi-WUC-digit formats in preparation for follow-on detail analysis.

[13] Boeing Document BCS "CDEP Production System", February 1979

TABLE 9 - LCOMIZED AFM 66-1 DATA FORMATS



VI - CONCLUSION

1. SYNOPSIS

This report describes the work accomplished under Tasks I through IV of an eigt task study to: "Develop Maintenance METRICS To Forecast Resource Demands of Weapon Systems." The underlying purpose of these first four tasks was to develop a quantitative foundation which the remaining tasks used in the analysis of maintenance metrics.

The objectives were: 1) identify, acquire, and review related publications to develop a historical METRICS data file and bibliography; 2) develop a matrix of selected aircraft versus common subsystems and selected functionally similar equipments for detail analysis; 3) establish the subset of likely parameters that may have an impact on maintenance resource demands of selected subsystem equipments; and 4) develop a data base for input to the analyses tasks.

Results of work accomplished during these four tasks and included in this report are: 1) development of an extensive METRICS Data File and bibliography of selective documents pertinent to this study; 2) identification of 352 individual equipments within 30 functionally similar subsystems on seven different aircraft; 3) established 193 maintenance impact parameters; and 4) the acquisition and processing of seven million transactions along with 400 supplemental data parameters obtained from on-site visits at nine operational Air Force bases.

2. PROBLEMS

During the data acquisition phase the inevitable problem that plagues all studies of this type is the long lead time for the contractor to actually receive the data. Although all known remedies were taken to avoid this problem a unique situation arose that is worthy of mention. Specific forms must be used to order various types of data. The form used by an Air Force agency in-house is not necessarily the form that the contractor is required to use for his need-to-know to obtain the same data from the Air Force. It behooves the requestor to ascertain from the point of contact, even though a specific order form is stipulated, if it will in fact release the required data to the contractor.

3. RECOMMENDATIONS

Other than the recommendation discussed in the problem area above, establishing a need-to-know through the appropriate command is essential for a smooth transition of data from an operational command to the study team. The key to this step is the assigned point of contact. He should be contacted prior to any visit and provided with the details on the types of data desired and the functional areas to be visited.

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APPENDIX A

METRICS CATALOG DATA ENTRY FORM

METRICS CATALOG DATA ENTRY FORM

The following enumerates the title, contents, and purpose of the field as shown in Figure A-1. Since the alpha character preceeding each field is only used by the computer for identification of that field, it will not be included with the title.

DOC - This is the sequential accession number assigned by EAC investigators for tracking and retrieval purposes.

TITLE - Document title.

PERSONAL AUTHOR - Originator of the document.

DOC NO. - Document number.

FORM - The actual physical form of the document, i.e., hard copy, magazine, microfiche, etc.

SOURCE - The name of the company or government agency from whom the document was obtained or ordered from.

*/DOC SHIST ____________

*ST (Title)

SPA (Personal Author)

SDN (Doc. No.)

*SF FORM

- Forms
- Tech. Reports
- Documents/Guide
- Briefs/Papers
- News Release
- Magazine
- Computer Tape
- List/Index
- Card Deck
- Microfiche
- Brochure
- Tech. Data
- Book
- Logs
- Summary

*SL (Source)

SS TYPE OF DATA

- Human Resources
  - Manpower
  - Skill Level
  - Experience
  - Training
  - Costs
  - Task Analysis
- Material Resources
  - Spares
  - Consumable Materiels
  - AGE
  - Training Equipment
  - Test Equipment
  - POL
  - Modifications/TCTO Kits
  - Costs
- Operations Data
  - Utilization
  - Sorties
  - Landings
  - Inventory/(No. Acft.)
  - Turn Around
  - Aborts
  - Availability
  - Dependability
- Maintenance Data
  - Organizational Level
  - Intermediate Level
  - Depot Level
  - Vendor
  - Manhours
  - Task Analysis
  - Modifications/TCTO
- Reliability Data
  - Failure Rates
  - Failure Distribution
  - Failure Modes
  - Cost
- Safety Data
  - Accidents/Incidents
  - Cost
- Cost Data
  - Human Resources
  - Material Resources
  - Actuals
  - Estimates

SP PHASE

- Conceptual
- Validation
- Development
- Production
- Operation

SNR (Number Reports) ____________

SBD (Order Date) ____________

SCD (Received Date Pseudo) ____________

SB FILED

- EAC MECCA
- BAC Kent Library
- BCAC Renton Library
- BAC Military Publications
- METRICS Master File

*SQ QUALITY OF DATA

- Source Listing
- Screened Documents
- Useable
- Not Used

SX Address

SD Published

SA

FIGURE A-1 METRICS CATALOG DATA ENTRY FORM

TYPE OF DATA - Seven major areas, each with several sub-areas, are identified to categorize the contents of each document.

PHASE - That particular phase of life the contents of the document covers.

NUMBER REPORTS - Applicable to listings/indexes as to the number of documents contained therein.

ORDER DATE - The date a document was ordered from the source.

RECEIVED DATE PSEUDO - A fictitious date utilized by the computer to indicate all documents ordered but not received.

FILED - An internal study requirement to specify the location of a document.

QUALITY OF DATA - *An internal study requirement to* distinguish between listings/indexes/bibliographies, reviewed documents, and whether the information was of use to this study.

ADDRESS - Source address.

PUBLISHED - Document publish date.

ABSTRACT - If the contents of a document reviewed did not contribute to any area within the study, an abstract was written for informational purposes.

APPENDIX B

PARAMETERS IDENTIFIED AND DEFINED

TABLE B-1 MAINTENANCE PARAMETERS

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
M01	Maint. Action Demand Per Acft.	Real	No./Acft.
M02	Avg. OR RATE	Real	Percent (Hrs. OR/Hours Possessed)
M03	Avg. NORM RATE	Real	Percent (Hrs. NORM/Hours Possessed)
M04	Avg. NORS RATE	Real	Percent (Hrs. NORS/Hours Possessed)
M05	Total Maint. Personnel Authorized	Real	No./Acft.
M06	Total Maint. Personnel Assigned	Real	No./Acft.
M07	Total 3 Level Maint. Personnel Assigned	Real	No./Acft.
M08	Total 5 Level Maint. Personnel Assigned	Real	No./Acft.
M09	Total 7 Level Maint. Personnel Assigned	Real	No./Acft.
M10	Total 9 Level Maint. Personnel Assigned	Real	No./Acft.
M11	Total Maint. Personnel Authorized (AMS)	Real	No./Acft.
M12	Total Maint. Personnel Assigned (AMS)	Real	No./Acft.
M13	Total 3 Level Maint. Personnel Assigned (AMS)	Real	No./Acft.
M14	Total 5 Level Maint. Personnel Assigned (AMS)	Real	No./Acft.

TABLE B-1 MAINTENANCE PARAMETERS
CONT'D

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
M15	Total 7 Level Maint. Personnel Assigned (AMS)	Real	No./Acft.
M16	Total 9 Level Maint. Personnel Assigned (AMS)	Real	No./Acft.
M17	Total Maint. Manhours Expended Per Acft.	Real	Hours/Acft.
M18	AMS Maint. Manhours Expended Per Acft.	Real	Hours/Acft.
M19	Maint. Concept	Scaled	Weighted Number
M20	Avg. Turn-Around Time - Maint.	Real	Clock Hours
M21	Acft. FOD (All Causes)	Real	No./Acft.
M22	Total General Support (01-09) Manhours Per Acft.	Real	Hours/Acft.
M23	Total General Support - 01 Manhours Per Acft. Ground Handling and Servicing	Real	Hours/Acft.
M24	Total General Support - 02 Manhours Per Acft. Aircraft Cleaning	Real	Hours/Acft.
M25	Total General Support - 03 Manhours Per Acft. Look Phase of Scheduled Inspections	Real	Hours/Acft.
M26	Total General Support - 04 Manhours Per Acft. Special Inspections	Real	Hours/Acft.
M27	Total General Support - 05 Manhours Per Acft. Preservation and Storage	Real	Hours/Acft.
M28	Total General Support - 06 Manhours Per Acft. Arming and Disarming	Real	Hours/Acft.

TABLE B-1 MAINTENANCE PARAMETERS
CONT'D

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
M29	Total General Support - 07 Manhours Per Acft. Preparation and Maintenance of Records	Real	Hours/Acft.
M30	Total General Support - 09 Manhours Per Acft. In-Shop General Support	Real	Hours/Acft.

TABLE B-2 AVIONICS PARAMETERS

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
A01	Maint. Action Demand Per Acft.	Real	No./Acft.
A02	Equipment Location on Acft.	Scaled	Weighted Number
A03	Equipment Weight	Real	LB's
A04	Equipment Volume	Real	Cu. In.
A05	SRU Count	Real	Number of SRU's
A06	Operating Temperature	Scaled	Weighted Number
A07	Cooling Method	Scaled	Weighted Number
A08	Protection Devices	Scaled	Weighted Number
A09	Number of Test Points (Org. Level)	Real	Number
A10	Required Age	Scaled	Weighted Number
A11	Age Availability	Real	Percent
A12	Age Unreliability	Real	Percent
A13	Avg. Operating Time Per Sortie	Real	Hours
A14	Failure/Malfunction Causes	Scaled	Weighted Number

TABLE B-2 AVIONICS PARAMETERS
CONT'D

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
A15	Retest OK Rate	Real	Percent
A16	On-Off Cycles Per Flying Hour	Real	Number/10 Fly Hr.
A17	On-Off Cycles Per Sortie	Real	Number/Sortie
A18	Ground/Flight Operating Ratio	Real	Percent
A19	Failure/Abort Ratio	Real	Percent
A20	Equipment Density	Real	Cu. In. (Transform A03, A04)
A21	Equipment Total Maint. Man Hr. Per Acft.	Real	No./Acft.
A22	Equipment Total Removals Per Acft.	Real	No./Acft.
A23	Equipment Unscheduled Removals Per Acft.	Real	No./Acft.
A24	Equipment Scheduled Removals Per Acft.	Real	No./Acft.
A25	Equipment Ground Aborts Per Acft.	Real	No./Acft.
A26	Equipment Air Aborts Per Acft.	Real	No./Acft.
A27	Equipment Cannibilizations Per Acft.	Real	No./Acft.

TABLE B-3 ENGINE PARAMETERS

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
P01	Maint. Action Demand Per Acft.	Real	No./Acft.
P02	Total No. of Installed Engines	Real	Total Number
P03	Take-Off Thrust Per Engine	Real	LB's/10
P04	Weight Per Engine	Real	LB's/10
P05	Volume Per Engine	Real	Cu. Ft./10
P06	Density Per Engine	Real	Cu. Ft./10 (Transform P04,P05)
P07	No. Compressor Sections Per Engine	Real	Number
P08	No. Compressor Blades Per Engine	Real	Number
P09	Turbine Section Size	Real	Feet
P10	Max. Engine Combustion Temp.	Real	Degrees "C"
P11	Max. Engine Fuel Flow	Real	LB's/Hr.
P12	Min. Engine Fuel Flow	Real	LB's/Hr.
P13	Engine Prime Depot	Scaled	Number (Scaled Value)
P14	Engine Age Availability	Real	Percent

TABLE B-3 ENGINE PARAMETERS CONT'D

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
P15	Engine Age Unreliability	Real	Percent
P16	Engine Vibration Factors	Scaled	Weighted Value
P17	Total Maint. Manhours Per Installed Engine	Real	Manhours
P18	Total Engine Maint. Manhours Per Acft.	Real	No./Acft.
P19	Total Engine Removals Per Acft.	Real	No./Acft.
P20	Unscheduled Engine Removals Per Acft.	Real	No./Acft.
P21	Scheduled Engine Removals Per Acft.	Real	No./Acft.
P22	Engine Ground Aborts Per Acft.	Real	No./Acft.
P23	Engine Air Aborts Per Acft.	Real	No./Acft.
P24	Engine Parts Cannibilization Per Acft.	Real	No./Acft.

TABLE B-4 OTHER EQUIPMENT PARAMETERS - MAINT. RESOURCE DEMAND (MRD)

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
R01	Maintenance Action Demand Per Acft.	Real	No/Acft.
R02	Equipment Total Maint. Man Hr. Per Acft.	Real	No/Acft.
R03	Equipment Total Unscheduled Removals Per Acft.	Real	No/Acft.
R04	Equipment Ground Aborts Per Acft.	Real	No/Acft.
R05	Equipment Air Aborts Per Acft.	Real	No/Acft.
R06	Equipment Cannibilizations Per Acft.	Real	No/Acft.

TABLE B-5 OTHER EQUIPMENT PARAMETERS

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
F01	Location of Equipment on the Aircraft	Scaled	Scaled Value (See Note 1)
F02	Primary Material - Composition Technology Level	Scaled	Scaled Value (See Note 2)
F03	Equipment Weight	Real	Pounds
F04	Equipment Volume	Real	Cu. In.
F05	Operating Temperature	Real	Degrees F
F06	Support Equipment Complexity	Scaled	Scaled Value (See Note 3)
F07	Support Equipment Reliability	Real	Percent
F08	Type of Failure Problems	Scaled	Scaled Value (See Note 4)
F09	Inflight Squawk Verification Rate	Real	Percent
F10	On/Off Cycles Per Sortie	Real	Cycles/Sortie
F11	Ground to Flight Operating Ratio	Real	Percent
F12	Relative Reliability of Equip. Driving Force	Scaled	Scaled Value (See Note 5)
F13	Removals to Access Other Equipment	Real	No/Acft.
F14	Severity of FOD	Scaled	Scaled Value (See Note 6)

TABLE B-5 OTHER EQUIPMENT PARAMETERS
CONT'D

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
F15	Principle Failure Cause	Scaled	Scaled Value (See Note 7)
F16	Equipment Protection Methodology	Scaled	Scaled
F17	Equipment Pressurization Level	Real	PSI
F18	Rain Removal Technology (Windshield)	Scaled	Scaled Value
F19	Mounting Position	Scaled	Scaled Value
F20	Power Rating (Generators)	Real	KVA Rating
F21	No. of Tire Ply's (Tires)	Real	Ply's Per Tire
F22	Landings Per Tire (Tires)	Real	Landings Per Tire
F23	Avg. Tire Cost (Tires)	Real	Cost Per Tire
F24	Securing Method Technology	Scaled	Scaled Value

TABLE B-6 OPERATIONAL PARAMETERS

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
001	Maint. Action Demand Per Acft.	Real	No./Acft.
002	Years Acft. Have Been on Base	Real	No. Years
003	Avg. Mission Mix	Scaled	Weighted Number
004	Aircraft Grounded Time	Real	Percent of Days
005	Avg. Take-off Speed	Real	Knots
006	Median Take-off Distance	Real	Feet
007	Percent of Max. Take-off Wt.	Real	Percent
008	Avg. Climb Rate	Real	Feet/Min.
009	Avg. Cruise Speed	Real	Knots
010	Avg. Cruise Altitude	Real	Feet/10
011	Avg. Descent Rate	Real	Feet/Min.
012	Avg. Landing Speed	Real	Knots
013	Minimum Landing Distance	Real	Feet
014	Avg. Landing Wt.	Real	LB's/1000

TABLE B-6 OPERATIONAL PARAMETERS
CONT'D

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
015	Total Flying Hours Per Acft.	Real	Hours/Acft.
016	Training Flying Hours Per Acft.	Real	Hours/Acft.
017	Operations Flying Hours Per Acft.	Real	Hours/Acft.
018	Misc. Flying Hours Per Acft.	Real	Hours/Acft.
019	Total Landings Per Acft.	Real	Landings/Acft.
020	Training Landings Per Acft.	Real	Landings/Acft.
021	Operations Landings Per Acft.	Real	Landings/Acft.
022	Misc. Landings Per Acft.	Real	Landings/Acft.
023	Avg. No. of Acft. on Alert	Real	Acft./Mo.
024	Avg. No. of Deployed Acft.	Real	Acft./Mo.
025	Total Sorties Per Acft.	Real	Sorties/Acft.
026	Training Sorties Per Acft.	Real	Sorties/Acft.
027	Operations Sorties Per Acft.	Real	Sorties/Acft.
028	Misc. Sorties Per Acft.	Real	Sorties/Acft.

TABLE B-6 OPERATIONAL PARAMETERS CONT'D

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
029	Avg. Possessed Acft.	Real	Acft./Mo.
030	Maximum Acft. Speed	Real	Knots
031	Maximum Acft. Ceiling	Real	Feet/10
032	Acft. Crew Size	Real	Number/Acft.
033	Avg. Sortie Length	Real	Hours/Sortie
034	Accidents (Major/Minor) Per Acft.	Real	No./Acft.
035	Incidents Per Acft.	Real	No./Acft.

TABLE B-7 ENVIRONMENTAL PARAMETERS

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
E01	Maint. Action Demand Per Acft.	Real	No./Acft.
E02	Base Altitude	Real	Feet
E03	Runway Direction	Real	Degrees
E04	Distance to Mountains	Real	Miles
E05	Direction of Mountains	Real	Number
E06	No. of Snow Days	Real	Days
E07	Total Snow Fall	Real	Inches
E08	Mean Snow Depth	Real	Inches
E09	No. of Rain Days	Real	Days
E10	Total Rain Fall	Real	Inches
E11	No. of Hail Days	Real	Days
E12	Relative Humidity (Avg.)	Real	Percent
E13	No. of Thunder Days	Real	Days
E14	No. of Sleet Days	Real	Days

TABLE B-7 ENVIRONMENTAL PARAMETERS CONT'D

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
E15	No. of Fog Days	Real	Days
E16	Predominate Wind Direction	Real	Degrees
E17	Maximum Crosswind's Less Than 10 MPH	Real	Days
E18	Maximum Crosswind's 10-19 MPH	Real	Days
E19	Maximum Crosswind's 20-29 MPH	Real	Days
E20	Maximum Crosswind's 30-39 MPH	Real	Days
E21	Maximum Crosswind's 40-49 MPH	Real	Days
E22	Maximum Crosswind's Greater Than 50 MPH	Real	Days
E23	Mean Temperature	Real	Degrees "F"
E24	Mean Minimum Temperature	Real	Degrees "F"
E25	Mean Maximum Temperature	Real	Degrees "F"
E26	Days Maximum Temp. Was Above 80^{0} "F"	Real	Days
E27	Days Minumum Temp. Was Below 32^{0} "F"	Real	Days
E28	Total Number of Obstructions To Vision	Real	Number of Events

TABLE B-7 ENVIRONMENTAL PARAMETERS
CONT'D

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
E29	Predominate Type of Obstructions	Scaled	Weighted No.
E30	Avg. Obstruction Type	Scaled	Weighted No.
E31	Avg. Obstruction Severity	Scaled	Weighted No.

TABLE B-8 AIRCRAFT GENERAL PARAMETERS

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
G01	Maint. Action Demand Per Acft.	Real	No./Acft.
G02	Years Since Aircraft Was Produced	Real	Years
G03	Aircraft Empty Wt.	Real	LB's/10
G04	Max. Gross Wt. - Take-off	Real	LB's/10
G05	Aircraft Wing Area	Real	Sq/Ft.
G06	Aircraft Aspect Ratio	Real	Percent
G07	Total Fuel Capacity	Real	Gallon's
G08	Avg. Aircraft Wing Load	Real	LB's/Sq. Ft.
G09	Years Since Engine Production	Real	Years
G10	No. of Installed Engines Per Acft.	Real	Number
G11	Engine Wt. Per Acft. (All Engines)	Real	LB's.
G12	Total Thrust Per Acft.	Real	LB's/10
G13	Designated Climb Rate	Real	Feet/Min.
G14	No. of Generator's Per Acft.	Real	No./Acft.

TABLE B-8 AIRCRAFT GENERAL PARAMETERS
CONT'D

VARIABLE I.D. NUMBER	LABEL NAME	KIND OF DATA REAL/SCALED	UNIT OF MEASURE
G15	Total Maint. Manhour Per Flight Hour	Real	Manhours
G16	Years Since Acft. First Flight	Real	Years

APPENDIX C

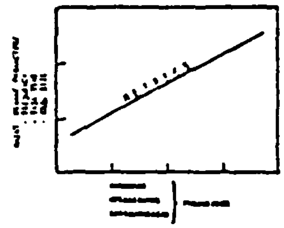
BASE VISIT - AUTHORIZATION LETTER

To: Headquarters Strategic Air Command
Attn: LGM
Offutt Air Force Base, Nebraska 68113

25 April 1978
In Reply Refer To
2-3552-0078-032

Subject: Air Force Contract F33615-77-C-0075, "Development of Maintenance Metrics to Forecast Resource Demands on Weapon Systems" (METRICS)

Contract Monitor:
Mr. Frank Maher
AFHRL/ASR
WPAFB, Ohio 45433
PH (513)255-3771



Contract Manager:
Mr. George R. Herrold
Boeing Aerospace Co.
M/S 4A-45, P.O. Box 3999
Seattle, Washington 98124
PH (206)655-1941

INTRODUCTION: The Boeing Aerospace Company is performing a study for the Air Force to develop maintenance metrics to forecast resource demands of operational and new development aircraft.

OBJECTIVE: This research is designed to determine how hardware, operational, and environmental parameters impact maintenance demands on aircraft. More accurate METRICS (hardware [measures] and operational and environmental [weightings]) will be developed for incorporation into the Air Force method (Logistics Composite Model [LCOM]) of determining maintenance resource demands.

ASSISTANCE REQUIRED: In compliance with the subject contract, authorization is requested to visit the maintenance organization of the following bases to obtain applicable aircraft operational and maintenance type data. Specific data categories and elements will be coordinated with the various points of contact prior to visit.

BASE	DESIRED DATE (LENGTH OF VISIT)
Fairchild AFB (B-52/KC-135 Wing)	June 26, 1978 (2 days)
Plattsburgh AFB (FB-111 Wing)	June 29, 1978 (2 days)

Gordon A. Eckstrand
Dr. Gordon A. Eckstrand
Director: Advanced System Division (AFHRL/AS)
Air Force Human Resources Laboratory
Wright-Patterson AFB, Ohio

George R Herrold
George R Herrold
Contract Manager
Boeing Aerospace
Seattle, Washington

AD-A096 688   BOEING AEROSPACE CO SEATTLE WA PRODUCT SUPPORT/EXPER--ETC F/G 5/1
DEVELOPMENT OF MAINTENANCE METRICS TO FORECAST RESOURCE DEMANDS--ETC(U)
FEB 80 D K HINDES, G A WALKER, D H WILSON   F33615-77-C-0075
UNCLASSIFIED D194-10089-1   NL

2 OF 2
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END
DATE
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APPENDIX D

BASE VISIT - DATA ACQUISITION FORMS

METRICS | MAINTENANCE -

(BASE - BY MONTH)

1. NUMBER OF AIRCRAFT PROCESSED (1977)?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

2. TOTAL SORTIES FLOWN (1977)?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

3. AVERAGE SORTIES PER AIRCRAFT (1977)?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

4. TOTAL FLYING HOURS (1977)?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

(BASE - BY MONTH)

5. AVERAGE FLYING HOURS PER AIRCRAFT (1977)?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

6. AVERAGE LANDINGS PER AIRCRAFT (1977)?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

7. AVERAGE "OR" RATE (1977)?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

8. AVERAGE "NORM" RATE (1977)?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

(BASE - BY MONTH)

9. AVERAGE "NORS" RATE (1977)?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

10. TOTAL MAINTENANCE PERSONNEL AUTHORIZED BY SQUADRON?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

11. TOTAL MAINTENANCE PERSONNEL ASSIGNED BY SQUADRON?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

12. TOTAL 3 LEVELS ASSIGNED BY SQUADRON?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

(BASE - BY MONTH)

13. TOTAL 5 LEVELS ASSIGNED BY SQUADRON?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

14. TOTAL 7 LEVELS ASSIGNED BY SQUADRON?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

15. TOTAL 9 LEVELS ASSIGNED BY SQUADRON?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

16. NUMBER OF RESERVE MAINTENANCE MAN MONTHS UTILIZED BY SQUADRON FOR THIS WEAPON SYSTEM?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

(BASE - BY MONTH)

17. NUMBER OF TOTAL MAINTENANCE MANHOURS UTILIZED BY SQUADRON FOR THIS WEAPON SYSTEM?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

(AIRCRAFT)

18. DO YOU HAVE ANY WORK THAT IS CONTRACTED WHICH WOULD INFLUENCE OR IMPACT REPORTED "MDC" DATA? (EXAMPLE - SOME OF THE MAINTENANCE OR SERVICING WORK IS CONTRACTED)

19. HAVE THERE BEEN SUBSYSTEMS OR "LRU'S" WHICH HAVE BEEN IDENTIFIED AS THE CAUSE FOR REPEATED ACCIDENTS, INCIDENTS OR HAZARDS?

20. ARE THERE PARTICULAR SUBSYSTEMS/LRU'S ON WHICH CANNIBALIZATION FREQUENTLY OCCUR? IF YES WHAT ARE THEY?

21. ARE THERE TROUBLESOME "LRU'S" OR SUBSYSTEMS WHICH ARE EITHER NOT IDENTIFIED WITH A WUC OR NOT ADEQUATELY DESCRIBED BY A WUC?

(FOR EXAMPLE - ARE THERE SUBSYSTEMS/LRU'S FOR WHICH WORK ACCOMPLISHED COULD BE REPORTED UNDER SEVERAL WUC'S)?

(AIRCRAFT)

22. ESTIMATE OF APU OPERATING TIME PER FLIGHT HOURS? WHAT PERCENT IS GROUND AND FLIGHT?

23. IS POMO (PRODUCTION ORIENTED MAINTENANCE ORGANIZATION) CONCEPT UTILIZED AND HOW LONG HAS IT BEEN IN EFFECT?

24. IS QUEEN BEE CONCEPT UTILIZED?

25. AT WHAT PHASE OF FLIGHT DO MOST ABORTS OCCUR (PERCENTAGE)? (PRIOR TO ENGINE START, TAXI, TAKE-OFF, CRUISE, ETC.)

(AIRCRAFT)

26. WHAT IS THE AVERAGE MAINTENANCE TURNAROUND TIME?

27. HAVE YOU PERCEIVED ANY RELATIONSHIP BETWEEN THE TYPE OF MISSIONS THE AIRCRAFT FLIES AND ITS MAINTENANCE DEMAND RATES?

28. WHAT MAJOR MODIFICATIONS WERE ACCOMPLISHED DURING 1977?

29. IS AIRCRAFT FOD A PROBLEM? IF YES, WHAT ARE THE MAJOR CAUSES?

CAUSE	PERCENT OF TOTAL
A)	
B)	
C)	
D)	
E)	

(AIRCRAFT)

30. DO RESERVES WORK ON AIRCRAFT?

31. DO YOU HAVE ANY STUDIES, INVESTIGATIONS, HISTORIES, PRESENTATIONS, OR REPORTS THAT MAY BE RELATED TO THIS PROJECT?

32. WHAT ARE THE SUPPORT GENERAL (01-09 BY WUC) UNITS PRODUCED, MANHOURS, CLOCKHOURS, TOTAL BY MONTH (1977)? (SEE PREPARED WORKSHEET)

METRICS I AVIONICS -

WUC'S

1. NATIONAL STOCK NUMBER AND/OR PART NUMBER? (QUICK REFERENCE LIST? YES OR NO)

2. LOCATION OF EQUIPMENT ON AIRCRAFT?

3. NUMBER OF EQUIPMENT (QPA) IN AIRCRAFT?

4. EQUIPMENT WEIGHT?

5. EQUIPMENT VOLUME.

6. DENSITY OF EQUIPMENT (LBS. PER CUBIC FOOT) (COMPUTE FROM 4 AND 5 ABOVE)

7. WHAT IS THE SRU COUNT (COMPLEXITY) OF THIS EQUIPMENT?

8. WHAT IS THE OPERATING TEMPERATURE RANGE?

9. WHAT IF ANY IS THE METHOD OF COOLING THIS EQUIPMENT?

AMBIENT AIR________

FORCED AIR________

LIQUID_______

OTHER (SPECIFY)___________

10. WHAT TYPE OF PROTECTIVE DEVICES ARE USED WITH THIS EQUIPMENT?

11. NUMBER OF TEST POINTS FOR IN-CIRCUIT TESTING?

12. WHAT AGE OR TEST EQUIPMENT IS REQUIRED FOR MAINTENANCE ON THIS SUBSYSTEM?

13. WHAT PERCENT OF THE TIME IS THE REQUIRED AGE OR TEST EQUIPMENT AVAILABLE WHEN NEEDED?

14. WHEN USING THIS AGE OR TEST EQUIPMENT WHAT PERCENT OF THE TIME IS IT NOT RELIABLE?

15. AVERAGE OPERATING TIME BY TYPE MISSION?

A)

B)

C)

D)

E)

F)

G)

16. WHAT GENERATES MOST OF THE MAJOR PROBLEMS?

A) ENVIRONMENT

B) EQUIPMENT USAGE (OPS/MISSION)

C) HARDWARE DESIGN

D) RELATIVE VIBRATION LEVEL

HIGH MEDIUM LOW

DISCUSSION:

17. WHAT PERCENT OF THE INFLIGHT SQUAWKS CAN BE VERIFIED ON THE GROUND?

18. DO FLYING HOURS DETERMINE THE FAILURE RATE OF THE SUBSYSTEM OR IS IT SOME OTHER FACTOR?

19. WHAT IS THE NUMBER OF ON-OFF CYCLES?

A) PER FLYING HOUR__________

B) PER SORTIE__________

20. WHAT IS THE RATIO OF EQUIPMENT GROUND OPERATING TIME TO FLYING HOURS?

21. CAN MOST ABORTS AGAINST THE SPECIFIC SUBSYSTEM BE TRACED TO AN ACTUAL EQUIPMENT FAILURE? WHAT PERCENT?

22. WHAT IS THE AVERAGE CREW SIZE FOR A GIVEN MAINTENANCE ACTION?

23. WHAT FACTORS DETERMINE THE CREW SIZE FOR A GIVEN MAINTENANCE ACTION?

24. WHAT DEPOT IS PRIME ON THIS EQUIPMENT?

25. DO ANY BASE SAFETY REGULATIONS HINDER MAINTENANCE? IF SO HOW?

IF AFTER THE DISCUSSION A PORTION OF THE EQUIPMENT WHICH BOEING SELECTED TO STUDY WERE NOT MENTIONED, REPEAT SOME OF THE ABOVE QUESTIONS SPECIFICALLY ADDRESSING THE IGNORED EQUIPMENTS/SUBSYSTEMS.

METRICS | ENGINE -

1. ENGINE THRUST?

   A) TAKE-OFF____________

   B) CRUISE______________

2. NATIONAL STOCK NUMBER AND/OR PART NUMBER, PARTS LISTS OR APPLICABLE T.O.?

3. ENGINE WEIGHT?

4. ENGINE VOLUME? (LENGTH AND DIAMETER) (CU. FT.)

5. DENSITY OF EQUIPMENT (LBS. PER CUBIC FOOT)? (COMPUTED FROM 4 ABOVE)

6. WHAT IS THE SRU COUNT? (DETAIL PARTS LIST OR TIME CHANGE LIST)

7. WHAT IS THE PRIMARY METAL ALLOY/MATERIAL OF ENGINE?

8. HOW MANY COMPRESSION SECTIONS IN THE ENGINE?

9. HOW MANY COMPRESSION BLADES, TOTAL OR PER SECTION?

10. WHAT IS THE SIZE OF TURBINE SECTION, FEET, INCHES?

11. WHAT IS THE ENGINE COMBUSTION EXIT TEMPERATURE: MAXIMUM, MINIMUM?

12. WHAT IS THE FUEL FLOW RANGE (MINIMUM, MAXIMUM)?

13. WHAT DEPOT IS PRIME ON THIS ENGINE?

14. ARE ENGINES REPAIRED THRU USE OF A QUEEN BEE CONCEPT?

15. WHAT AGE OR TEST EQUIPMENT IS REQUIRED FOR MAINTENANCE ON THIS ENGINE?
(TA-   )

16. WHAT PERCENT OF THE TIME IS THE REQUIRED AGE OR TEST EQUIPMENT AVAILABLE WHEN NEEDED?

17. WHEN USING THIS AGE OR TEST EQUIPMENT WHAT PERCENT OF THE TIME IS IT NOT RELIABLE?

18. IS ENGINE FOD A PROBLEM? IF YES WHAT ARE THE MAJOR CAUSES?

	CAUSE	PERCENT OF TOTAL
A)		
B)		
C)		
D)		
E)		

19. WHAT IS THE VIBRATION FACTOR ON THE ENGINE?

    A) HIGH

    B) MEDIUM

    C) LOW

20. IS THERE A WAY TO OBTAIN DATA CONCERNING THE POWER/THRUST CYCLES AN ENGINE EXPERIENCES DURING A TYPICAL FLIGHT?

21. GENERAL SUPPORT DATA
(09 DATA SPECIAL BREAKOUT)

TYPE OF MAINTENANCE	CREW SIZE	TYPE OF PEOPLE AFSC	CLOCK HOURS	NO. ACTIONS PER MONTH	MMH'S PER ACTION	PERCENT OF MMH'S CHARGED TO WUC	
						09	SYSTEM
A. ENGINE SHOP MAINTENANCE							
B. ENGINE BUILD UP							
C. ENGINE TEARDOWN							
D. ENGINE CONDITIONING							
E. TEST CELL							
F. LINE MAINTENANCE							
G. R&R ENGINE							
H. REMOVE ONLY							
I. REPLACE ONLY							
J. TEARDOWN							
K. ENGINE OVERHAUL (BASE LEVEL IF APPLICABLE)							

WUC'S

NOTE: Questions 1 thru 27 (pages 1 thru 7) are General Questions that pertain to all Equipments.

Attachment 1 (pages A1 thru A6) have Specific Questions for Specific Equipments. Complete only those questions pertaining to the equipment identified by the WUC on the top of this page.

1. NATIONAL STOCK NUMBER AND/OR PART NUMBER? (QUICK REFERENCE LIST? YES OR NO)

2. MANUFACTURED BY? (COMPANY)

3. LOCATION OF EQUIPMENT ON AIRCRAFT?

____FOREWARD SPACES	____BOMB BAY	____EXTERNAL MOUNTS
____MIDSHIP SPACES	____WHEEL WELLS	____PROXIMITY OF ENGINES
____AFT SPACES	____COCKPIT	____OTHER (SPECIFY)

4. NUMBER OF EQUIPMENT (QPA) IN AIRCRAFT?
I.E. NO. OF COMPONENTS ON BOARD?

OTHER EQUIPMENTS -

5. EQUIPMENT WEIGHT?

6. EQUIPMENT VOLUME.

HEIGHT -

LENGTH -

WIDTH -

OR

DIAMETER -

7. WHAT IS THE PRIMARY MATERIAL?

8. PRESSURIZED?

YES LIMIT OR RANGE?

NO

9. WHAT IS THE OPERATING TEMPERATURE RANGE?

10. WHAT IF ANY IS THE METHOD OF COOLING THIS EQUIPMENT?

    AMBIENT AIR________

    FORCED AIR_________

    LIQUID______________

    OTHER (SPECIFY)__________

11. WHAT TYPE OF PROTECTIVE DEVICES ARE USED WITH THIS EQUIPMENT?

_____BIT FAULT IND.	_____RADIATION SHIELDS	_____FUSES
_____CIRCUIT BREAKER	_____COVERS, REMOVABLE	_____RELAYS
_____PHY DAMAGE GUARDS	_____SHOCK MOUNTS	_____OTHER (SPECIFY)

12. WHAT ARE THE OPERATING RESTRICTIONS? (TEMP, TIME, ETC.)

    ON THE GROUND

    IN THE AIR

13. PERCENT OF FAILURES CAUSED BY EXCEEDING RESTRICTIONS?

14. WHAT AGE OR TEST EQUIPMENT IS REQUIRED FOR MAINTENANCE ON THIS EQUIPMENT?

_____SIMPLE HAND TOOLS/METERS
_____BASIC ELECTRICAL TEST EQUIPMENT
_____COMMERCIAL TEST SETS/SUPPORT EQUIPMENT
_____GENERAL PURPOSE MILITARY TEST SETS/SUPPORT EQUIPMENT
_____DEDICATED TEST SETS/SUPPORT EQUIPMENT
_____COMPUTERIZED/AUTOMATIC TEST STATIONS

15. WHEN USING THIS AGE OR TEST EQUIPMENT WHAT PERCENT OF THE TIME IS IT NOT RELIABLE?

16. WHAT GENERATES MOST OF THE MAJOR PROBLEMS?

A) ENVIRONMENT

B) EQUIPMENT USAGE (MAINT., OPS., TYPE MISSION)

C) HARDWARE DESIGN

D) RELATIVE VIBRATION LEVEL

HIGH MEDIUM LOW

E) OTHER

DISCUSSION:

17. WHAT PERCENT OF THE INFLIGHT SQUAWKS CAN BE VERIFIED ON THE GROUND?

18. DO FLYING HOURS DETERMINE THE FAILURE RATE OF THE SUBSYSTEM OR IS IT SOME OTHER FACTOR.

19. WHAT IS THE NUMBER OF ON-OFF CYCLES?

    A) PER FLYING HOUR________

    B) PER SORTIE____________

20. WHAT IS THE RATIO OF EQUIPMENT GROUND OPERATING TIME TO FLYING HOURS?

21. WHAT DEPOT IS PRIME ON THIS EQUIPMENT?

22. HOW IS EQUIPMENT OPERATED?

    A) ELECTRICAL

    B) MECHANICAL

    C) HYDRAULIC

    D) PNEUMATIC

    E) OTHER - WHAT?

23. IS THIS EQUIPMENT REMOVED TO FACILIATE OTHER MAINTENANCE? IF YES, HOW OFTEN AND FOR WHAT?

24. TYPE OF MAINTENANCE AUTHORIZED?

    ORGANIZATIONAL (LINE) - %

    INTERMEDIATE (SHOP) - %

    DEPOT - %

    DISCUSSION: NRTS/CONDEMNED/ETC.

25. IS FOD A PROBLEM? IF YES, WHAT AND HOW?

26. HAVE THERE BEEN ANY MAJOR MODIFICATIONS? (MAJOR IMPROVEMENTS OR DEGRADATIONS) IF YES - WHEN AND WHAT?

27. DO ANY OF THE FOLLOWING CONTRIBUTE TO HIGH FAILURES?

AIRCRAFT HIGH SPEED

LOW LEVEL FLIGHT

TURBULANCE

AIR REFUELING

LANDINGS

GUN FIRINGS

ROCKET FIRINGS

BOMBING

OTHER - SPECIFY

IF YES, HOW AND WHAT FAILS?

11 AIRFRAME

RADOME

HOW IS IT SECURED TO THE AIRCRAFT?

WINDSHIELD

METHOD OF RAIN REMOVAL?

CURING TIME?

NESA OR HEATED TYPE?

WINGS

TYPE OF SCREWS/FASTNERS FOR SKIN, ACCESS PANELS, DOORS, ETC.?

ANGLE OF SWEEP?

POSITION RELATIVE TO FUSELAGE?

UPPER

MID

LOWER

STRESSED SKIN?

YES

NO

WET WING?

YES

NO

12 COCKPIT FURNISHING

SEAT ASSY

EJECTION

YES	UPWARD
NO	DOWNWARD

13 LANDING GEAR

TIRES	MAIN TIRE	NOSE TIRE	OUTRIGGER TIRE B-52G
SIZE			
PRESSURE-PSI			
WEIGHT			
PLY'S			
COSTS			
NEW			
RECAP			
LANDINGS/PER TIRE			
PROBLEMS			
FOD			
RUNWAY			
TAXIWAY			
ETC.			
NO. NRTS/%			
NO. CONDEMNED/%			

13. LANDING GEAR (CONT)

	CREW SIZE	CLOCK HOURS	MANHOURS
R & R			
INSPECT ON ACFT			
BENCH CHECK			
TEARDOWN			
BUILD UP			

DISCUSSION:

WHEELS	MAIN	NOSE
NO. ON ACFT		
SPLIT RIM		
SINGLE OR DOUBLE AXLE		
TYPE OF BEARINGS		

BRAKES

TYPE OF BRAKE

NUMBER OF PUCKS

ANTI-SKID (YES OR NO)

HYDRAULIC

PNEUMATIC

BRAKE PRESS RANGE

EMERGENCY BRAKE TYPE

STEERING - YES, NO

14 FLIGHT CONTROLS

HORIZIONAL STABILIZER?

RUDDER?

FLAPS?

- TYPE OF SKIN SCREWS, FASTNERS, ACCESS PANELS/DOORS
- PROBLEM AREAS

41 ENVIRONMENTAL CONTROL

WATER SEPERATOR

42 ELECTRICAL POWER GENERATING

GENERATORS

KVA RATING?

OVERLOAD RATING/TIME LIMIT?

44 EXTERIOR LIGHTING

45 HYDRAULICS

PUMPS

VARIABLE DISPLACEMENT

PISTON

GALLONS PER MIN (GPM) RATING

PSI RATING

46 FUEL

TANKS

BLADDER

INTEGRAL

CAPACITY: LB'S -

GALLONS -

SEALING/FIRE SURPRESSION

SELF

FOAM

OTHER

PRESSURIZED:

YES

NO

47 LIQUID OXYGEN

REGULATOR

CONVERTER

49 MISC. EQUIPMENT

FIRE DETECTION SYSTEM

(AIRCRAFT)

1. BASE TENANT STATUS? TENANT__________ HOW LONG__________

2. HOW LONG HAVE AIRCRAFT BEEN AT THIS BASE? YEARS__________ MONTHS__________

3. WHAT IS THE MISSION MIX OF THE AIRCRAFT FOR AN AVERAGE MONTH?

TYPE OF MISSION	PERCENT OF TOTAL
A)	
B)	
C)	
D)	
E)	
F)	
G)	

(AIRCRAFT)

4. WERE ANY AIRCRAFT GROUNDED FOR ANY LENGTH OF TIME DURING 1977? IF SO, HOW MANY, HOW LONG, AND REASON.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

5. AVERAGE TAKE-OFF SPEED?

6. AVERAGE TAKE-OFF DISTANCE BY TYPE MISSION?

7. AVERAGE TAKE-OFF WEIGHT BY TYPE OF MISSION AS A PERCENTAGE OF MAXIMUM TAKE-OFF WEIGHT?

(AIRCRAFT)

8. AVERAGE CLIMB RATE BY TYPE MISSION?

9. AVERAGE CRUISE SPEED BY TYPE MISSION?

10. AVERAGE CRUISE ALTITUDE BY TYPE MISSION?

11. AVERAGE DESCENT RATE BY TYPE MISSION?

12. LANDING SPEED?

(AIRCRAFT)

13. MINIMUM LANDING DISTANCE?

14. AVERAGE LANDING WEIGHT?

15. AVERAGE CREW SIZE (AIRCRAFT) BY TYPE MISSION?

16. DURING 1977 DID THIS WING PARTICIPATE IN ANY SPECIAL EXERCISES (I.E., WITH THE NAVY OR MARINES, ETC.)? IF SO HOW LONG, NUMBER OF AIRCRAFT AND LOCATION.

(BASE - BY MONTH)

17. AVERAGE SORTIE LENGTH BY TYPE OF MISSION (1977)?

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
A)												
B)												
C)												
D)												
E)												
F)												
G)												

18. FLYING HOURS BY TYPE OF MISSION (1977)?

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
A)												
B)												
C)												
D)												
E)												
F)												
G)												

METRICS I

OPERATIONS -

(BASE - BY MONTH)

19. TOTAL NUMBER OF LANDINGS BY TYPE OF MISSION (1977)?

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
A)												
B)												
C)												
D)												
E)												
F)												
G)												

20. AVERAGE NUMBER OF BASE AIRCRAFT ON ALERT (1977)?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

METRICS | OPERATIONS -

(BASE - BY MONTH)

21. AVERAGE NUMBER OF AIRCRAFT DEPLOYED (1977)?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

22. NUMBER OF SORTIES FLOWN BY TYPE OF MISSION (1977)?

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
A)												
B)												
C)												
D)												
E)												
F)												
G)												

(PARAMETERS BY BASE)

ALTITUDE OF BASE?

GEOGRAPHY OF AREA.

A) HILLY

B) FLAT

C) DESERT

D) ETC.

DIRECTION OF MAIN RUNWAYS.

DISTANCE OF NEAREST MOUNTAINS?

TOTAL DAYLIGHT HOURS PER MONTH.

DISTANCE OF BASE FROM NEAREST BODY OF FRESH WATER?

DISTANCE OF BASE FROM NEAREST BODY OF SALT WATER?

(PARAMETERS BY BASE BY MONTH)

NUMBER OF SNOW EVENTS IN MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF DAYS OF SNOW IN MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

INCHES OF SNOW BY MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF RAIN EVENTS IN MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF DAYS OF RAIN IN MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

INCHES OF RAIN BY MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

(PARAMETERS BY BASE BY MONTH)

NUMBER OF HAIL EVENTS IN MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF DAYS WITH HIGH PRESSURE.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF DAYS WITH LOW PRESSURE.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

PERCENT RELATIVE HUMIDITY BELOW 50%.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

PERCENT RELATIVE HUMIDITY OVER 50%.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

PERCENT RELATIVE HUMIDITY OVER 70%.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

(PARAMETERS BY BASE BY MONTH)

PERCENT RELATIVE HUMIDITY OVER 80%.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

PERCENT RELATIVE HUMIDITY OVER 90%.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

PREDOMINATE DIRECTION FROM WHICH WIND BLOWS EACH MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

PERCENT TIME WIND BLOWS FROM SALT WATER.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF DAYS WITH MAXIMUM WIND BELOW 10 MPH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF DAYS WITH MAXIMUM WIND BETWEEN 10-20 MPH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

(PARAMETERS BY BASE BY MONTH)

NUMBER OF DAYS WITH MAXIMUM WIND BETWEEN 20-30 MPH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF DAYS WITH MAXIMUM WIND BETWEEN 30-40 MPH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF DAYS WITH MAXIMUM WIND BETWEEN 40-50 MPH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF DAYS WITH MAXIMUM WIND OVER 50 MPH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

MEAN MONTHLY TEMPERATURE.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

LOWEST TEMPERATURE FOR MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

(PARAMETERS BY BASE BY MONTH)

HIGHEST TEMPERATURE FOR MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

AVERAGE MAXIMUM DAILY TEMPERATURE.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

AVERAGE MINIMUM DAILY TEMPERATURE.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF FREEZING PRECIPITATION EVENTS.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF DAYS WITH FOG CONDITIONS.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

PERCENT TIME SAND OR DUST OBSCURATION PRESENT.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

(PARAMETERS BY BASE BY MONTH)

AVERAGE OZONE CONCENTRATION PER MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF AIR INVERTIONS PER MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

NUMBER OF POLLUTION ALERTS PER MONTH.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

AVERAGE MONTHLY POLLUTION LEVEL.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

PERCENT TIME SALT HAZE/SPRAY CONDITIONS PRESENT.

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

WHAT WERE THE NUMBER OF BIRD STRIKES ON OR NEAR THE BASE DURING 1977?

JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC

(PARAMETERS BY BASE BY MONTH)

DID THIS BASE HAVE ANY ABNORMAL ENVIRONMENTAL EVENTS SUCH AS HURRICANE, TORNADO, ETC., DURING 1977? IF SO PROVIDE PRIMARY STATISTICS SUCH AS NUMBER OF DAYS, TIME OF YEAR, WINDS, AIRCRAFT EVACUATION, ETC.

THROUGH YOUR EXPERIENCE, HAVE YOU PERCEIVED POSSIBLE RELATIONSHIPS BETWEEN ANY ENVIRONMENTAL FACTORS AND THE AIRCRAFTS MAINTENANCE DEMAND RATES?

(AIRCRAFT)

YEARS SINCE AIRCRAFT WAS PRODUCED.

AIRCRAFT WEIGHT.

MAXIMUM GROSS WEIGHT AT TAKE-OFF.

AIRCRAFT DENSITY (LBS PER CUBIC FEET).

AIRCRAFT VOLUMN (CUBIC FEET).

WING AREA.

ASPECT RATIO.

TOTAL FUEL CAPACITY IN LBS. OR GALLONS.

(AIRCRAFT)

WET AREA.

AVERAGE WING LOAD.

TYPE OF WINDSHIELD (FLAT VS CURVED)

NUMBER OF YEARS SINCE PRODUCTION OF ENGINE.

LOCATION OF ENGINES ON AIRCRAFT.

NUMBER OF ENGINES ON AIRCRAFT.

NUMBER OF PODDED NACELLES.

WEIGHT OF EACH ENGINE.

(AIRCRAFT)

VOLUMN OF ENGINE.

DENSITY OF ENGINE (LBS. PER CUBIC FOOT).

THRUST PER ENGINE IN LBS.

OUTLET TEMPERATURE.

INLET TEMPERATURE.

FUEL TEMPERATURES.

FUEL PRESSURES.

(AIRCRAFT)

RPM OF ENGINE AT

A) IDLE

B) TAXI

C) DURING FLIGHT

ENGINE FIRE DETECTION (SINGLE OR DUAL CIRCUIT).

THRUST REVERSORS (YES OR NO).

FUEL GRADE.

DESIGNED CLIMB RATE.

NUMBER OF INFLIGHT OPERATED ELECTRIC GENERATORS.

MAXIMUM SPEED.

(AIRCRAFT)

MAXIMUM CEILING.

YEARS SINCE INITIAL PRODUCTION.

WHAT ARE THE HIGH COST LRU'S IN TERMS OF DOLLARS?

COST OF HARDWARE.

GLOSSARY OF ABBREVIATIONS

ACFT	Aircraft
AFB	Air Force Base
AFHRL	Air Force Human Resources Laboratory
AFLC	Air Force Logistics Command
AFM	Air Force Manual
AFMEA	Air Force Management Engineering Agency
AFMSMET	Air Force Maintenance and Supply Management Engineering Team
AFSC	Air Force Systems Command
AGE	Aerospace Ground Equipment
AMS	Avionics Maintenance Squadron
ATC	Air Training Command
AVG	Average
BCS	Boeing Computer Services
BLIS	Base Level Information System
BMW	Bomb Wing
CDEP	Common Data Extraction Program
DCM	Deputy Commander for Maintenance
DCO	Deputy Commander for Operations
DDC	Defense Documentation Center
DLSIE	Defense Logistics Studies Information Exchange
DOC	Document
EAC	Experience Analysis Center

FMS	Field Maintenance Squadron
FOD	Foreign Objects Damage
FTW	Fighter Training Wing
GIDEP	Government-Industry Data Exchange Program
HF	High Frequency
HR	Hour
HRS	Hours
IFF	Identify Friend or Foe
JCN	Job Control Number
LB's	Pounds
LCOM	Logistic Composite Model
LRU	Line Replaceable Unit
MAC	Military Airlift Command
MAINT	Maintenance
MAW	Military Airlift Wing
MMH	Maintenance Manhour
MMM	Maintenance Manpower Model
NCOIC	Non Commissioned Officer in Charge
NO	Number
NORM	Not Operational Ready Maintenance
NORS	Not Operational Ready Supply
OIC	Officer in Charge
OR	Operational Ready
O&S	Operations and Support
QC	Quality Control

R&R	Remove and Replace
R/T	Receiver/Transmitter
SAC	Strategic Air Command
SRU	Shop Removable Unit
STINFO	Scientific and Technical Information
TAC	Tactical Air Command
TACAN	Tactical Air Navigation
TFW	Tactical Fighter Wing
TO	Technical Order
TR	Technical Report
TTW	Tactical Training Wing
UHF	Ultra High Frequency
USAFE	United States Air Forces Europe
WUC	Work Unit Code
WT	Weight

THE BOEING COMPANY

REVISIONS

LTR	DESCRIPTION	DATE	APPROVAL
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